

The American Midland Naturalist

Devoted to Natural History; Primarily
that of the Prairie States

Founded by J. A. Nieuwland, C.S.C.



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The Life-Forms of the Flowering Plants of Indiana*

Sr. Elizabeth Seton McDonald, S.C.

I.—Introduction

Life-forms have been defined as the units of ecological plant-geography. The object of ecological plant-geography is the investigation of the relationship of plants to their environment. Primarily, in this respect, the vegetative body of the plant is concerned displaying greater variation with changing environmental conditions than the floral structures show. Hence, as Braun-Blanquet states, this "form which the vegetative body of the plant produces as the result of all the life-processes which are affected by the environment" is variously termed vegetative form, growth-form, or life-form (Braun-Blanquet 1932).

Organic structure and the determinable effects of the environmental factors upon the plant are both involved in any attempt to establish a system of life-forms. Depending upon whether the emphasis is placed on the morphological structures or on the ecological aspects, two major categories of life-form systems can be readily distinguished, namely, physiognomic (Humboldt, Kerner et al.) and epharmonic (Warming, Raunkiaer et al.).

It is not intended to survey in this connection the various systems heretofore proposed nor to enter into lengthy theoretical discussions regarding their respective values, since a comprehensive exposition of nearly all important writings has been given by Du Rietz (1931). This author attempts to overcome the multitude of apparent difficulties, resulting from the practical application of certain characters in classification or from the particular viewpoint assumed, by adopting six more or less independent systems to be paralleled with one another. Unfortunately, this work remains unfinished to date, thus making its use impossible for the time being.

The most recent studies, however, are concerned largely with the detailed analysis of certain phases of life-forms both morphological (Meusel 1935, Rauh 1937) and physiological (Iversen 1936, Gelting 1934), or in the subdivision of specific life-form classes (Gelting).

Of all the systems developed that of Raunkiaer has been most widely employed. This is due in a large measure, no doubt, to the striking sim-

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plidity and ready applicability of the system. The present study uses this system of classification in determining the life-forms of the species of Indiana. In addition the "extended scheme" as devised by Turrill (1929) has been employed.

This study attempts to determine more precisely than has hitherto been done the life-forms to which the plants of Indiana should be assigned. To this end all of the herbaceous species have been studied in the herbarium. The study has been supplemented by some field observations. Morphological literature has been drawn upon freely in determining the nature and origin of the perennating organs, for the purpose of making the correct subdistinctions in some of the classes of Raunkiaer.

In the classification of the Phanerophytes, the bud-height was determined from the measurements cited by Deam in "Trees of Indiana" (1932) and "Shrubs of Indiana" (1932). Other tree manuals were used, when Deam gave the diameter of the trunk but not the height of the tree.

Deam's "Grasses of Indiana" (1929) was used in connection with the herbarium material for the study of the grasses. Various manuals have been used for checking the duration of species.

Upon the determination of their life-forms, according to the system of Raunkiaer, is based a "spectrum" of the flowering plants of Indiana, which is compared with the published "spectra" of other regions of North America.

Acknowledgements.—This problem was undertaken at the suggestion of Dr. Theodor Just and the study was carried on under his direction. The writer is grateful for his interest and assistance, especially for his bringing to her attention the extremely pertinent and excellent work of the late Theodor Holm and the recent contributions by Wm. Troll and his collaborators.

The writer acknowledges the assistance of Mr. Chas. C. Deam in furnishing a list of the species definitely known to occur in Indiana and substantiated by herbarium records; the kindness of Dr. Paul C. Standley of the Field Museum in giving permission to use the library and herbarium under his care.

To Dr. Stanley A. Cain, Dr. Henry S. Conard, and to Frère Marie-Victorin the writer is indebted for reading and criticizing this paper. However, the writer assumes full responsibility for any errors or omissions occurring in the study.

For the many courtesies and considerations extended by the Rev. Francis J. Weninger, C.S.C., and other administrative officers of the University the writer is most grateful.

II.—The System of Raunkiaer

Raunkiaer bases his classification on a single, important feature, the adjustment of plants to the unfavorable season, that is, to a cold winter or to a dry, hot summer. This adjustment depends upon the location and protection of the perennating organs. On this basis five main classes are distinguished: Phanerophytes, Chamaephytes, Hemicryptophytes, and Therophytes. Phanerophytes have their perennating buds on aerial shoots extending more than 25 cm. above the ground. Chamaephytes place their renewal buds on shoots lying on the ground, or on shoots not more than 25 cm. above the ground. The buds of the Hemicryptophytes lie in the soil surface, while those of the Cryptophytes are buried in the soil or submersed in water. Thero-

phytes perennate by means of seed. Each of these classes characterizes a definite plant-climate.

A. *Phanerophytes*.—This class properly belongs to warm, moist regions. The buds placed on shoots which project into the air at varying heights above the soil surface are afforded less protection than those of the other classes. Upon the basis of bud-height, the class is subdivided as follows:

- I. Megaphanerophytes—height more than 30 m.
- II. Mesophanerophytes—height 8-30 m.
- III. Microphanerophytes—height 2-8 m.
- IV. Nanophanerophytes—height below 2m.

A further distinction is made with respect to leaf-fall and bud-covering, which increases these four sub-types to twelve. Herbaceous Phanerophytes are temporarily grouped with the Nanophanerophytes. With the recognition of two other groups, the Epiphytes and Stem-succulents, the total number of Phanerophytes is raised to fifteen:

I.-II. Megaphanerophytes and Mesophanerophytes.

1. Evergreen Mega- without bud-scales.
2. Evergreen Meso- without bud-scales.
3. Evergreen Mega- with bud-scales.
4. Evergreen Meso- with bud-scales.
5. Deciduous Mega- with bud-scales.
6. Deciduous Meso- with bud-scales.

III. Microphanerophytes.

7. Evergreen Micro- without bud-scales.
8. Evergreen Micro- with bud-scales.
9. Deciduous Micro- with bud-scales.

IV. Nanophanerophytes.

10. Evergreen Nano- without bud-scales.
11. Evergreen Nano- with bud-scales.
12. Deciduous Nano- with bud-scales.
13. Herbaceous Phanerophytes.

V. Epiphytic Phanerophytes. (14).

VI. Stem-succulent Phanerophytes. (15).

There is no sharp delimitation of types. A species occurring as a Microphanerophyte in one climate may be found as a Nanophanerophyte in a less favorable climate. This shows "that types are in harmony with nature; with a change in climate there occurs a corresponding change in life-form, which is indeed an expression of the climate." (Raunkiaer 1934, p. 34).

B. *Chamaephytes*.—These are in particular harmony with the Arctic climate marked by its cold, desiccating winds and deeply frozen soil. The hibernating buds placed close above or on the soil surface are protected by the long winter snows. This life-form is characteristic, too, of altitudinal zones corresponding in conditions to the Arctic latitudinal zone. They are adapted,

also, to the long dry seasons found within the warm and warm-temperate regions. Here the renewal buds are protected by decaying vegetation.

Chamaephytes are subdivided according to the position of the bud with reference to the soil, and the direction of growth of the vegetative shoots.

- I. Suffrutescent Chamaephytes — aerial shoots orthotropic; buds just above soil surface due to the dying back of the aerial shoots during the unfavorable season.
- II. Passive Chamaephytes — aerial shoots orthotropic, later taking up a horizontal position due to their weight, thus placing renewal buds on soil surface.
- III. Active Chamaephytes — aerial shoots plagiotropic and prostrate, renewal buds on soil surface.
- IV. Cushion Chamaephytes — buds close to soil surface because shoots are low. This group is in harmony with Alpine conditions.

The balanced adjustment of life forms and climate is well illustrated by the Chamaephytes. A transition of form can and does occur with changing climatic conditions. Under less favorable conditions the Chamaephyte form will be found occurring as a Hemicryptophyte form. This plasticity at times presents difficulty in the classification of forms. It emphasizes, however, the sensitivity of such forms as indicators of climate, as Raunkiaer has pointed out in his studies of the Arctic and Mediterranean regions.

C. *Hemicryptophytes*.—This life-form class is characteristic of the temperate regions of the earth. Before the unfavorable season sets in, the aerial shoots die down to the level of the ground. Only the subterranean shoots with the hibernating buds persist through this season. These buds are situated in the soil surface with varying degrees of amount and kind of protection. The sub-types are demarcated by their external modification for life in the soil. Great morphological diversity prevails in this life-form, as will be noted in the following classification:

- I. Proto-Hemicryptophytes—no radical rosette, leaves cauline.
 - a) without stolons; b) with stolons.
- II. Semi-Rosette plants—radical rosette, cauline leaves.
 - a) without stolons; b) with stolons.
- III. Rosette plants—radical rosette (some exceptions); cauline leaves none, few, or reduced to scales.
 - A. Sympodial.
 - a) without stolons; b) with stolons.
 - B. Monopodial.
 1. Axis bears only foliage leaves.
 - a) Aerial shoots bear foliage leaves; stolons usually absent.

- b) Aerial shoots without foliage leaves; \pm stolons.
- 2. Axis bears both scale and foliage leaves; \pm stolons.
- 3. Axis bears only scale leaves.

D. *Cryptophytes*.—The *Cryptophytes* which are relatively few in number are not the dominant life-form of any particular climate. With their buds buried in the soil or submersed in water, they are the best adapted of all life-forms to resist desiccation and sudden marked changes of temperature. The *Cryptophytes* are divided first according to the medium in which the hibernating buds are placed, and these units are again subdivided according to the morphological character of the perennating organ which bears the rejuvenating buds.

I. *Geophytes*—renewal buds in the soil.

- | | |
|---------------|-----------------------------------|
| a) Rhizome | d) Bulb |
| b) Stem-tuber | e) Root-bud |
| c) Root-tuber | f) Root-parasite (Braun-Blanquet) |

II. *Helophytes*—buds submersed in water; vegetative shoots project in air.

III. *Hydrophytes*—buds submersed in water; vegetative shoots submersed.

E. *Therophytes*.—*Therophytes* are characteristic of the sub-tropical regions. They pass the unfavorable season in the form of seeds which are peculiarly adapted to resist drought and heat. Raunkiaer classes winter-annuals as *Therophytes*, but those annuals which behave at times as biennials he counts as *Hemicryptophytes*.

III.—Discussion of *Geophytes*

The *geophytes* offer many problems. Their successful analysis can be undertaken only by resorting to morphological characters as Raunkiaer himself has done. The structures which denote the perennial habit of species and which take the active part in their hibernation and rejuvenation are rhizomes, pseudo-rhizomes, tubers, bulbs, stolons, runners, and creeping stems. These terms are used here as defined by Holm (1925). For a proper classification of these vegetative organs as life-form characters, the mature material of either field or herbarium is often inadequate. To understand the true nature of the perennating organs, Holm stresses the necessity of a study of the seedling-stage of the species and its further development during a period of one or two years. Only by following the development of root-systems, hypocotyl, cotyledonary buds, and plumule can the complexity of the mature system be interpreted with any degree of accuracy (Pls. 1-5). This is especially necessary at times for distinguishing axes of primary and secondary growth.

In the literature there is no agreement in the use of the terms "rhizome," "stolon," and "runner." No distinction is made between horizontal root-

shoots and stolons, between runners and creeping stems. This is confusing and misleading.

While Holm bases his distinction upon morphological origin and development, Warming (1918) takes into consideration, also, certain external characters exhibited by the mature organ such as direction of growth, length and thickness of internodes, etc. His use of "subole" for hypogeal runners and "stolon" for epigeal runners, his substitution of "mesocormus" for "pseudo-rhizome" (Nilsson 1882) further complicates matters. For forms intermediate between rhizome and subole he proposes the term "rhizode."

In his studies of subterranean organs, Hitchcock (1889) used "crown-former" to designate the stem-base complex with its perennating buds, and "caudex" (Henslow 1895) for the vertical rhizome. Moll (1934) makes "stock" synonymous with "caudex" and Jackson (1928) makes "caudex" synonymous with "rhizome." "Root-stock" is used it seems for any and every subterranean structure, particularly so in manuals.

Consequently, the following terms as defined by Holm have been accepted and followed in this study. The *rhizome* is a primary axis developed mostly from the plumule into a subterranean stem horizontal or vertical with monopodial or sympodial ramification. The axes of secondary order, cotyledonary shoots for example, are *stolons* when subterranean; *runners*, when aerial. *Pseudo-rhizomes* represent a combination of hypocotyl, persisting bases of aerial shoots with their buds, and sometimes the primary root. This type of perennating organ is characteristic of many American species (Pl. 7, Fig. 3). Many intermediate types occur between rhizomes and bulbs (Pl. 7, Fig. 4).

At this point it is opportune to express the writer's indebtedness to the excellent work of Theodor Holm, a student of Warming. Through a period of many years he described morphologically a large number of American plants. It is information on the vegetative structures by which hibernation and rejuvenation are effected that is indispensable in the correct determination of the life-forms of plants. Such information, incidentally, would often assist in a more satisfactory taxonomic treatment of the species concerned as exemplified by Holm's study on North American Violets (1933).

IV.—Biological Spectrum and Pteridophyte-quotient

For the purpose of using life-forms in the ecological characterization of definite climatic regions in the description of plant communities, Raunkiaer determined the proportion of each life-form class in the flora of the world as a whole. The resulting percentage distribution of species among the various life-form classes he termed the normal biological spectrum. The percentages of the various life-form classes among the species of any region, then, will be the biological spectrum of that region. The plant climate of this given region will be characterized by the life-form classes which in the biological spectrum of that region exceeds the percentage of the same life-form classes in the normal spectrum. Regions with similar spectra can be joined by the so-called iso-biochore. By means of the biochores phyto-climatic boundaries may be determined.

The normal spectrum includes only the Spermatophytes. For a statistical analysis of Pteridophytes, Raunkiaer computed a Pteridophyte-quotient (Pt.-Q) based upon the ratio existing between the total number of the Spermatophytes and Pteridophytes of the earth, a ratio of 25:1. The Pt.-Q of a local flora expresses the relation between the local ratio of Spermatophytes to Pteridophytes and the world ratio.

The percentages obtained for the Indiana spectrum showing 50.3% Hemicryptophytes as against 26% in the normal spectrum indicates that Indiana belongs to the Hemicryptophyte climate. The Pt.-Q 0.8 is in harmony with the Hemicryptophyte percentage for, as Raunkiaer points out, the Hemicryptophyte climate is not particularly favorable for Pteridophytes.

The following tables give the Indiana spectrum and Pt.-Q. For purposes of comparison the normal spectrum and some of the available spectra of certain other regions in North America are included.

TABLE 1. Biological spectrum of Indiana and the normal biological spectrum of Raunkiaer. (Symbols, page 694.)

Species	No. of spp.	Percentage distribution of spp.				
		Ph	Ch	H	Cr	Th
Native and naturalized	2109	14.3	1.9	49.0	18.0	16.7
Native	1837	15.3	1.7	50.3	19.6	13.0
Normal spectrum		46.0	9.0	26.0	6.0	13.0

TABLE 2. Biological spectra of Connecticut and Indiana representing sections of the east and middle-west, respectively.

Species	No. of spp.	Percentage distribution of spp.				
		Ph	Ch	H	Cr	Th
Connecticut	1453	15.0	1.9	49.4	21.7	11.7
Indiana	1837	15.3	1.7	50.3	19.6	13.0
Normal spectrum		46.0	9.0	26.0	6.0	13.0

TABLE 3. Biological spectra of some other regions of North America as prepared by Ennis (1928). Percentages for Death Valley are from Raunkiaer (1934). Spectra of Connecticut and Indiana are included for comparative purposes.

Species	No. of spp.	Percentage distribution of spp.				
		Ph	Ch	H	Cr	Th
Mississippi	1724	17.7	3.1	49.4	16.2	12.8
Alabama	2012	17.0	3.1	47.8	17.1	14.4
Connecticut	1453	15.0	1.9	49.4	21.7	11.7
Cape Breton	637	14.1	1.8	51.3	25.6	6.7
Indiana	1837	15.3	1.7	50.3	19.6	13.0
Iowa	1320	14.8	1.0	48.6	20.9	14.2
Olympic Peninsula	1015	11.0	6.0	52.0	22.0	9.0
Death Valley	294	26.0	7.0	18.0	7.0	42.0
Normal spectrum		46.0	9.0	26.0	6.0	13.0

- H—Hemicryptophytes
Hp—Proto-Hemicryptophytes with runners
Hs—Semi-Rosette without runners
Hr—Rosette without runners
Hpr—Proto-Hemicryptophytes with runners
Hsr—Semi-Rosette with runners
Hrr—Rosette with runners
(Runner is here used for either hypogaeal or epigeal shoot.)

Cr—Cryptophytes

G—Geophytes

Grh—Rhizome

Gst—Stem-tuber

Grt—Root-tuber

Gb—Bulb

Gr—Root-bud

Gp—Root-parasites.

HH—*Helo-, Hydrophytes*

(Within the Geophytes the root-parasites have been included, a group based on Braun-Blanquet's emended life-form system of Raunkiaer.)

Th—*Therophytes*S—*Stem Succulents*E—*Epiphytes*

D. 1. Evergreen tree. 2. Deciduous tree. 3. Evergreen shrub. 4. Deciduous shrub. 5. Woody liana or sprawler. 7. Plant with spines, thorns, or strong prickles. 9. Perennial herb, or sub-shrub, partially woody at the base, and the aerial parts dying back but not to ground level. 10. Grasses and grass-like plants. 11. Rush and sedge forms with suppressed leaves. 12. Perennial herbs and subshrubs with runners, or sprawling or

ascending or herbaceous or suffrutescent stems. 14. Rosette plants. 15. Herbaceous twining plants, generally dying down each year. 16. Perennial herbs dying down yearly, with perennial buds on more or less thick stock at ground level. 17. Geophytes. 18. Annual herbs. 19. Hydrophytes. 20. Parasites and saprophytes. (Few Indiana species fall in the categories omitted: 6, switch plants; 8, dwarf shrubs; 13, cushion plants).

References.—With but few exceptions no specific references have been included in the systematic list. These can be readily found in the list of references.

Systematic List

SPERMATOPHYTA

Families: 133. *A.* Genera: 669. Species: 2109.

B. h/142, h/181(+3), 2f/1340, ②/94(+15), ①/352(+42).

C. MM/122(+4), M/116(+4), N/63(+5), E/1, S/1, Ch/41(+2), H/1033(+2), G/265, HH/115, Th/352.

D. 1/6, 2/135(+4), 3/9, 4/130(+4), 5/40, 7/83, 9/20, 10/433, 11/24, 12/27, 14/73, 15/37, 16/661, 17/173, 18/352, 19/71(+3), 20/14.

GYMNOSPERMAE

Families: 2. *A.* Genera: 7. Species: 10. *B.* h/8, h/2. *C.* MM/8, N/2. *D.* 1/6, 2/2, 3/2.

1. *Taxaceae*

A. Genera: 1. Species: 1. *B.* h/1. *C.* N/1, *D.* 3/1.

Taxus canadensis Marsh.—*B.* h / C.N. / D.3.

2. *Pinaceae*

A. Genera: 6. Species: 9. *B.* h/8, h/1. *C.* MM/8, N/1. *D.* 1/6, 2/2, 3/1.

Pinus Strobus L.—*B.* h / C.MM / D.1.

P. Banksiana Lamb.—*B.* h / C.MM / D.1.

Pinus virginiana Mill.—*B.* h / C.MM / D.1.

Larix laricina (DuRoi) Koch.—*B.* h / C.MM / D.2.

Tsuga canadensis (L.) Carr.—*B.* h / C.MM / D.1.

Taxodium distichum (L.) L. C. Rich.—*B.* h / C.MM / D.2.

Thuja occidentalis L.—*B.* h / C.MM / D.1.

Juniperus communis L. var. *depressa* Pursh.—*B.* h / C.N / D.3.

J. virginica L.—*B.* h / C.MM / D.1.

ANGIOSPERMAE

Families: 131. A. Genera: 662. Species: 2099.

B. 1/134, 2/179(+3), 2/1340, 2/94(+15), 1/352(+42).

C. MM/114(+4), M/116(+4), N/61(+5), E/1, S/1, Ch/41(2) H/1033 (+2), G/265, HH/115, Th/352.

D. 2/133(+4), 3/7, 4/130(+4), 5/40, 7/83, 9/20, 10/433, 11/24, 12/27, 14/73, 15/37, 16/661, 17/173, 18/352, 19/71(+3), 20/14.

MONOCOTYLEDONEAE

Families: 20. A. Genera: 156. Species: 639.

B. 2/4, 2/556, 2/3, 1/79(+1).

C. M/4, N/1, Ch/1(+1), H/300, G/181, HH/73, Th/79.

D. 5/4, 7/4, 9/1, 10/433, 11/24, 14/10, 15/6, 16/34, 17/91, 18/79, 19/40 20/4.

3. Typhaceae

A. Genera: 1. Species: 2. B. 2/2. C. HH/2. D. 16/2.

Typha latifolia L.—B. 2/ / C.HH / D.16.*T. angustifolia* L.—B. 2/ / C.HH / D.16.

4. Sparganiaceae

A. Genera: 1. Species: 4. B. 2/4. C. HH/4. D. 16/4.

Sparganium eurycarpum Engelm.—B. 2/ / C.HH / D.16.*S. androcladum* (Engelm.) Morong—B. 2/ / C.HH / D.16.*S. americanum* Nutt.—B. 2/ / C.HH / D.16.*S. chlorocarpum* Rydb.—B. 2/ / C.HH / D.16.var. *acaule* (Beebey) Fern.

5. Potamogetonaceae

A. Genera: 3. Species: 25. B. 2/22, 1/3. C. HH/25. D. 19/25

Zannichella palustris L.—B. 2/ / C.HH / D.19.*Najas flexilis* (Willd.) Rostk. & Schmidt.—B. 1/ / C.HH / D.19.*N. guadalupensis* (Spreng.) Morong—B. 1/ / C.HH / D.19.*N. gracillima* (A. Br.) Magnus—B. 1/ / C.HH / D.19.*Potamogeton natans* L.—B. 2/ / C.HH / D.19.*P. americanus* Cham. & Schlecht.—B. 2/ / C.HH / D.19.*P. amplifolius* Tuckerm.—B. 2/ / C.HH / D.19.*P. capillaceus* Poir.—B. 2/ / C.HH / D.19.*P. diversifolius* Raf.—B. 2/ / C.HH. / D.19.*P. gramineus* var. *graminifolius* Fries—B. 2/ / C.HH/D.19.*P. pulcher* Tuckerm.—B. 2/ / C.HH / D.19.*P. angustifolius* Berch. & Presl—B. 2/ / C.HH / D.19.*P. illinoensis* Morong—B. 2/ / C.HH / D.19.**P. crispus* L.—B. 2/ / C.HH / D.19.*P. lucens* L.—B. 2/ / C.HH / D.19.*P. praelongus* Wulf.—B. 2/ / C.HH / D.19.*P. Richardsonii* (Benn.) Rydb.—B. 2/ / C.HH / D.19*P. zosteriformis* Fern.—B. 2/ / C.HH / D.19.*P. Friesii* Rupr.—B. 2/ / C.HH / D.19.

- P. foliosus* Raf. var. *genuinus* Fern.—B. 2f / C.HH / D.19.
var. *macellus* Fern.
P. pusillus var. *mucronatus* (Fieber) Graebn.—B. 2f / C.HH / D.19.
P. strictifolius Benna. var. *typicus* Fern.—B. 2f / C.HH / D.19.
var. *rutiloides* Fern.
P. panormitanus Biv.—Bern. var. *major* G. Fisch.—B. 2f / C.HH / D.19.
var. *minor* Biv.
Polamogeton Robbinsii Oakes—B. 2f / C.HH / D.19.
f. *cultellatus* Fassett
P. pectinatus L.—B. 2f / C.HH / D.19.

6. *Juncaginaceae*

- A. Genera: 2. Species: 3. B. 2f / 3. C. H / 3. D. 14 / 3.
Triglochin maritima L.—B. 2f / C.Hr. / D.14.
T. palustris L.—B. 2f / C.Hrr / D.14.
Scheuchzeria palustris var. *americana* Fern.—B. 2f / C.Hrr / D.14.

7. *Alismaceae*

- A. Genera: 4. Species: 10. B. 2f / 10. C. HH / 10. D. 16 / 10.
Alisma subcordatum Raf.—B. 2f / C.HH / D.16.
Echinodorus radicans (Nutt.) Engelm.—B. 2f / C.HH / D.16.
E. cordifolius (L.) Griseb.—B. 2f / C.HH / D.16.
Lophotocarpus calycinus (Engelm.) J. G. Smith—B. 2f / C.HH / D.16.
Sagittaria latifolia Willd.—B. 2f / C.HH / D.16.
var. *obtusata* (Muhl.) Wieg.
S. cuneata Sheldon—B. 2f / C.HH / D.16.
S. brevirostra Mack. & Bush—B. 2f / C.HH / D.16.
S. australis (J.G.Smith) Small—B. 2f / C.HH / D.16.
S. rigida Pursh—B. 2f / C.HH / D.16.
S. graminea Michx.—B. 2f / C.HH / D.16.

8. *Hydrocharitaceae*

- A. Genera: 2. Species: 3. B. 2f / 3. C. HH / 3. D. 19 / 3.
Anacharis canadensis (Michx.) Planch.—B. 2f / C.HH / D.19.
A. occidentalis (Pursh) Vict.—B. 2f / C.HH / D.19.
Vallisneria americana Michx.—B. 2f / C.HH / D.19.

9. *Gramineae*

- A. Genera: 62. Species: 210. B. 2f / 162, ② / (3), ① / 48(+1). C. N / 1,
Ch / (1), H / 148, G / 13, HH / (1), Th / 48. D. 10 / 210, 18 / 49.
Arundinaria gigantea (Walt.) Chapm.—B. 2f / C. N (Ch) / D.10.
**Bromus sterilis* L.—B. ① / C.Th / D.10, 18.
**B. tectorum* L.—B. ① / C.Th / D.10, 18.
**B. inermis* Leyss.—B. 2f / C.Hsr / D.10.
B. ciliatus L.—B. 2f / C.Hs / D.10.
B. purgans L.—B. 2f / C.Hs / D.10.
B. latiglumis (Shear.) Hitchc.—B. 2f / C.Hs / D.10.
**B. secalinus* L.—B. ① / C. Th / D.10, 18.
**B. brizaeformis* Fisch. & Mey.—B. ① / C.Th / D.10, 18.

- B. Kalmii* Gray.—B. 2f / C.Hs / D.10.
**B. mollis* L.—B. ① / C.Th / D.10, 18.
**B. commutatus* Schrad.—B. ① / C.Th / D.10, 18.
**B. japonicus* Thunb.—B. ① / C.Th / D.10, 18.
Festuca octoflora Walt.—B. ① / C.Th / D.10, 18.
 var. *tennella* (Willd.) Fern.
F. rubra L.—B. 2f / C.Hsr / D.10.
F. capillata Lam.—B. 2f / C.Hs / D.10.
**F. ovina* L.—B. 2f / C.Hs / D.10.
**F. elatior* L.—B. 2f / C.Hs / D.10.
**F. obtusa* Spreng.—B. 2f / C.Hs / D.10.
F. Shortii Kunth.—B. 2f / C.Hs / D.10.
Glyceria striata (Lam.) Hitchc.—B. 2f / C.Hs / D.10.
G. grandis Wats.—B. 2f / C.Hs / D.10.
G. canadensis (Michx.) Trin.—B. 2f / C.Hs / D.10.
G. pallida (Torr.) Trin.—B. 2f / C.Hs / D.10.
G. borealis (Nash) Batchelder.—B. 2f / C.Hs / D.10.
G. septentrionalis Hitchc.—B. 2f / C.Hs / D.10.
G. acutiflora Torr.—B. 2f / C.Hs / D.10.
**Poa annua* L.—B. ① / C.Th / D.10, 18.
P. Chapmanniana Scribn.—B. ① / C.Th / D.10, 18.
P. autumnalis Muhl.—B. 2f / C.Hs / D.10.
**P. compressa* L.—B. 2f / C.Hsr / D.10.
P. languida Hitchc.—B. 2f / C.Hs / D.10.
P. alsodes Gray.—B. 2f / C.Hs / D.10.
**P. trivialis* L. B. 2f / C. Hsr / D.10.
P. paludigena Fern. & Wieg.—B. 2f / C. Hsr / D.10.
**P. palustris* L.—B. 2f / C.Hs / D.10.
P. pratensis L.—B. 2f / C.Grh / D.10.
P. sylvestris Gray.—B. 2f / C.Hs / D.10.
P. Wolfii Scribn.—B. 2f / C.Hs / D.10.
P. cuspidata Nutt.—B. 2f / C.Hsr / D.10.
Eragrostis hypnoides (Lam.) BSP.—B. ① / C.Th / D.10, 18.
E. spectabilis (Pursh) Steud.—B. 2f / C.Hs / D.10.
**E. cilianensis* (All.) Link.—B. ① / C. Th / D. 10, 18.
E. capillaris (L.) Nees.—B. ① / C.Th / D. 10, 18.
E. Frankii C.A.Meyer.—B. ① / C.Th / D. 10, 18.
E. pectinacea (Michx.) Nees.—B. ① / C.Th / D. 10, 18.
Diarrhena americana Beauv.—B. 2f / C.Hsr / D. 10.
Uniola latifolia Michx.—B. 2f / C.Hsr / D. 10.
**Dactylis glomerata* L.—B. 2f / C.Hs / D.10.
Phragmites communis Trin.—B. 2f / C.Grh (HH) / D. 10.
Melica mutica Walt.—B. 2f / C. Hs / D.10.
M. nitens Nutt.—B. 2f / C. Hs / D.10.
Schizachne purpurascens (Torr.) Swallen.—B. 2f / C.Hs / D.10.
Triodia flava (L.) Smyth.—B. 2f / C.Hsr / D.10.
Triplasis purpurea (Walt.) Chapm.—B. ① / C.Th / D. 10, 18.
**Agropyron repens* (L.) Beauv.—B. 2f / C. Grh / D.10.

- *A. Smithii* Rydb.—B. 2f / C.Grh / D.10.
A. pauciflorum (Schwein.) Hitchc.—B. 2f / C.Hs / D.10.
A. subsecundum (Link) Hitchc.—B. 2f / C.Hs / D.10.
Elymus canadensis L.—B. 2f / C.Hs / D.10.
E. riparius Wieg.—B. 2f / C.Hs / D.10.
E. villosus Muhl.—B. 2f / C.Hs / D.10.
E. virginicus L.—B. 2f / C.Hs / D.10.
Hystrix patula Moench.—B. 2f / C.Hs / D.10.
**Hordeum pusillum* Nutt.—B. ① / C.Th / D. 10, 18.
**H. nodosum* L.—B. 2f / C.Hs / D.10.
**H. jubatum* L.—B. 2f, ②, ①, / C.H (Th) / D. 10, 18.
**Lolium perenne* L.—B. 2f / C.Hs / D.10.
Koeleria cristata (L.) Pers.—B. 2f / C.Hs / D.10.
Sphenopholis nitida (Spreng.) Scribn.—B. 2f / C.Hs / D.10.
S. intermedia (Rydb.) Rydb.—B. 2f / C.Hs / D.10.
S. obtusata (Michx.) Scribn.—B. 2f / C.Hs / D.10.
Deschampsia caespitosa (L.) Beauv.—B. 2f / C.Hs / D.10.
**Arrhenatherum elatius* (L.) Mert. & Koch.—B. 2f / C.Hs / D.10.
**Holcus lanatus* L.—B. 2f / C.Hs / D.10.
Danthonia spicata (L.) Beauv.—B. 2f / C.Hs / D.10.
Calamagrostis canadensis (Michx.) Beauv.—B. 2f / C. Hs / D.10.
C. inexpansa Gray.—B. 2f / C. Hsr / D.10.
Ammophila breviligulata Fern.—B. 2f / C.Grh / D.10.
Calamovilfa longifolia (Hook.) Scribn.—B. 2f / C.Grh / D.10.
**Agrostis alba* L.—B. 2f / C.Hsr / D.10.
**A. palustris* Huds.—B. 2f / C.Hsr / D.10.
A. Elliottiana Schultes.—B. ① / C. Th / D. 10, 18.
A. scabra Willd.—B. 2f, ②, / C.Hs / D.10.
A. hiemalis (Walt.) BSP.—B. ②, 2f / C.Hs / D.10.
A. perennans (Walt.) Tuckerm.—B. 2f / C.Hs / D.10.
Cinna arundinacea L.—B. 2f / C.Hs / D.10.
**Alopecurus pratensis* L.—B. 2f / C.Hs / D.10.
A. aequalis Sobol.—B. 2f / C.Hs / D.10.
A. carolinianus Walt.—B. ① / C.Th / D. 10, 18.
**Phleum pratense* L.—B. 2f / C.Hs / D.10.
Muhlenbergia capillaris (Lam.) Trin.—B. 2f / C.Hs / D.10.
M. Schreberi J.F.Gmel.—B. 2f / C.Hs / D.10.
M. sobolifera (Muhl.) Trin.—B. 2f / C.Hsr / D.10.
M. cuspidata (Nutt.) Rydb.—B. 2f / C.Hs / D.10.
M. glabriflora Scribn.—B. 2f / C.Hsr / D.10.
M. metxicana (L.) Trin.—B. 2f / C.Hsr / D.10.
M. brachyphylla Bush.—B. 2f / C.Hsr / D.10.
M. racemosa (Michx.) BSP.—B. 2f / C.Hsr / D.10.
M. tenuiflora (Willd.) BSP. B. 2f / C.Hsr / D.10.
M. foliosa (Roem. & Schult.) Trin.—B. 2f / C.Hsr / D.10.
M. sylvatica Torr.—B. 2f / C.Hsr / D.10.
 f. *attenuata* (Scribn.) Deam
Sporobolus vaginiflorus (Torr.) Wood.—B. ① / C.Th / D. 10, 18.

- S. clandestinus* (Spreng.) Hitchc.—B. 2f / C.Hs / D.10.
S. neglectus Nash—B.① / C. Th / D. 10, 18.
S. cryptandrus (Torr.) A. Gray—B. 2f / C. Hs / D. 10.
Sporobolus heterolepis A. Gray—B. 2f / C.Hs / D.10.
S. asper (Michx.) Kunth—B. 2f / C.Hs / D.10.
Brachyelytrum erectum (Schreb.) Beauv.—B. 2f / C.Hsr / D.10.
Millium effusum L.—B. 2f / C.Hsr / D.10.
Oryzopsis pungens (Torr.) Hitchc.—B. 2f / C.Grh / D.10.
O. asperifolia Michx.—B. 2f / C.Grh / D.10.
O. racemosa (J.E.Smith) Ricker.—B. 2f / C.Grh / D.10.
Stipa avenacea L.—B. 2f / C.Hs / D.10.
S. comata Trin. & Rupr.—B. 2f / C.Hs / D.10.
S. spartea Trin.—B. 2f / C.Hs / D.10.
Aristida tuberculosa Nutt.—B.① / C.Th / D. 10, 18.
A. dichotoma Michx.—B.① / C.Th / D. 10, 18.
A. longespica Poir.—B.① / C.Th / D. 10, 18.
A. intermedia Scribn. & Ball.—B.① / C.Th. D. 10, 18.
A. purpurascens Poir.—B. 2f / C.Hs / D. 10.
A. ramosissima Engelm.—B.① / C.Th / D. 10, 18.
A. oligantha Michx.—B.① / C.Th / D. 10, 18.
Leptochloa filiformis (Lam.) Beauv.—B.① / C.Th / D. 10, 18.
L. panicoides (Presl.) Hitch.—B.① / C.Th / D. 10, 18.
**Eleusine indica* (L.) Gaertn.—B.① / C.Th / D. 10, 18.
**Cynodon Dactylon* (L.) Pers.—B. 2f / C.Hsr / D.10.
Spartina pectinata Link.—B. 2f / C.Hsr / D.10.
Gymnopogon ambiguus (Michx.) BSP.—B. 2f / C.Hsr / D.10.
Bouteloua curtipendula (Michx.) Torr.—B. 2f / C.Hsr / D.10.
Hierochloë odorata (L.) Beauv.—B. 2f / C.Hsr / D.10.
**Anthoxanthum odoratum* L.—B. 2f / C.Hs / D.10.
**Phalaris arundinacea* L.—B. 2f / C.Grh / D.10.
Leersia virginica Willd.—B. 2f / C.Hsr / D.10.
L. oryzoides (L.) Sw.—B. 2f / C.Hsr / D.10.
L. lenticularis Michx.—B. 2f / C.Hsr / D.10.
Zizania aquatica L.—B.① / C.Th / D. 10, 18.
 var. *angustifolia* Hitchc.
Digitaria filiformis (L.) Koel.—B.① / C.Th / D. 10, 18.
**D. Ischaemum* (Schreb.) Muhl.—B.① / C.Th / D. 10, 18.
**D. sanguinalis* (L.) Scop.—B.① / C.Th / D. 10, 18.
Leptoloma cognatum (Schult.) Chase—B. 2f / C.Hs / D.10.
Paspalum repens Bergius—B. 2f / C.Hs / D.10.
P. circulare Nash—B. 2f / C.Hs / D.10.
P. pubiflorum var. *glabrum* Vasey—B. 2f / C.Hs / D.10.
P. pubescens Muhl.—B. 2f / C.Hs / D.10.
P. stramineum Nash—B. 2f / C.Hs / D.10.
Panicum dichotomiflorum Michx.—B.① / C.Th / D. 10, 18.
P. flexile (Gatt.) Scribn.—B.① / C.Th / D. 10, 18.
P. capillare L.—B.① / C.Th / D. 10, 18.
P. philadelphicum Bernh.—B.① / C.Th / D. 10, 18.

- P. Gattingeri* Nash—B.① / C.Th / D. 10, 18.
P. virgatum L.—B. 2f / C.Gr / D.10.
P. anceps Michx.—B. 2f / C.Gr / D.10.
P. stipitatum Nash—B. 2f / C.Hs / D.10.
P. agrostoides Spreng.—B 2f / C.Hs / D.10.
P. verrucosum Muhl.—B.① / C.Th / D. 10, 18.
P. depaperatum Muhl.—B. 2f / C.Hs / D.10.
P. perlongum Nash—B. 2f / C.Hs / D.10.
P. linearifolium Scribn.—B. 2f / C.Hs / D.10.
P. xalapense HBK.—B. 2f / C.Hs / D.10.
P. Bicknellii Nash—B. 2f / C.Hs / D.10.
P. microcarpon Muhl.—B. 2f / C.Hs / D.10.
P. dichotomum L.—B. 2f / C.Hs / D.10.
P. mattamusketense Ashe—B. 2f / C.Hs / D. 10.
P. boreale Nash—B. 2f / C.Hs / D.10.
P. lucidum Ashe—B. 2f / C.Hs / D.10.
P. yadkinense Ashe—B. 2f / C.Hs / D.10.
P. spretum Schultes—B. 2f / C.Hs / D.10.
P. Lindheimeri Nash—B. 2f / C.Hs / D.10.
P. auburne Ashe—B. 2f / C.Hs / D.10.
P. praecocius Hitchc. & Chase—B. 2f / C.Hs / D.10.
P. tennesseense Ashe—B. 2f / C.Hs / D.10.
P. albermarlense Ashe—B. 2f / C.Hs / D.10.
P. implicatum Scribn.—B. 2f / C.Hs / D.10.
P. meridionale Ashe—B. 2f / C.Hs / D.10.
P. huachucae Ashe—B. 2f / C.Hs / D.10.
 var. *fasciculatum* (Torr.) F. T. Hubb.
P. subvillosum Ashe—B. 2f / C.Hs / D.10.
P. scoparioides Ashe—B. 2f / C.Hs / D.10.
P. villosissimum Nash—B. 2f / C.Hs / D.10.
P. pseudopubescens Nash—B. 2f / C.Hs / D.10.
P. Deamii Hitchc. & Chase—B. 2f / C.Hs / D.10.
P. Addisonii Nash—B. 2f / C.Hs / D.10.
P. tsugetorum Nash—B. 2f / C.Hs / D.10.
P. columbianum Scribn.—B. 2f / C.Hs / D.10.
P. polyanthes Schultes—B. 2f / C.Hs / D.10.
P. sphaerocarpon Ell.—B. 2f / C.Hs / D.10.
P. Leibergii (Vasey) Scribn.—B. 2f / C.Hs / D.10.
P. oligoanthes Schultes—B. 2f / C.Hs / D.10.
P. Scribnerianum Nash—B. 2f / C.Hs / D.10.
P. Ashei Pearson—B. 2f / C.Hs / D.10.
P. commutatum Schultes—B. 2f / C.Hs / D.10.
P. clandestinum L.—B. 2f / C.Hs / D.10.
P. latifolium L.—B. 2f / C.Hs / D.10.
P. Boscii Poir.—B. 2f / C.Hs / D.10.
**Echinochloa crusgalli* (L.) Beauv.—B.① / C.Th / D. 10, 18.
E. Walteri (Pursh) Nash—B.① / C.Th / D. 10, 18.
**Setaria lutescens* (Wiegel.) F. T. Hubbard—B.① / C.Th / D. 10, 18.

- **S. viridis* (L.) Beauv.—B.① / C. Th / D. 10, 18.
 **S. italica* (L.) Beauv.—B.① / C.Th / D. 10, 18.
 **Setaria verticillata* (L.) Beauv.—B.① / C. Th / D. 10, 18.
Cenchrus pauciflorus Benth.—B.① / C.Th / D. 10, 18.
Erianthus alopecuroides (L.) Ell.—B.2f / C.Hs / D.10.
Andropogon scoparius Michx.—B.2f / C.Hs / D.10.
A. furcatus Muhl.—B.2f / C.Hs / D.10.
A. Elliottii Chapm.—B.2f / C.Hs / D.10.
A. virginicus L.—B.2f / C.Hs / D.10.
 **Sorghum halepense* (L.) Pers.—B.2f / C. Grh / D.10.
 **S. vulgare* var. *Drummondii* (Nees) Hitchc.—B.① / C.Th / D. 10, 18.
Sorghastrum nutans (L.) Nash.—B.2f / C. Hsr / D.10.
Tripsacum dactyloides L.—B.2f / C.Hs / D.10.

10. *Cyperaceae*

- A. Genera: 15. Species: 222. B.2f / 197, ①/25. C. H / 115 G / 67, HH / 15 (+20).
 Th / 25. D. 10 / 201, 11 / 21, 18 / 25.*
- Hemicarpha micrantha* (Vahl) Pax.—B.① / C.Th / D. 10, 18.
H. Drummondii Nees.—B.① / C.Th / D. 10, 18.
Dulichium arundinaceum (L.) Britt.—B.2f / C.HH / D.10.
Cyperus flavescens L.—B.① / C.Th / D. 10, 18.
C. diandrus Torr.—B.① / C.Th / D.10, 18.
C. rivularis Kunth.—B.① / C.Th / D. 10, 18.
 x *C. Nieuwlandii* Geise.—B.① / C. Th / D. 10, 18.
C. inflexus Muhl.—B.① / C.Th / D. 10, 18.
C. acuminatus Torr. & Hook.—B.① / C.Th / D. 10, 18.
C. pseudovegetus Steud.—B.2f / C.HH / D.10.
C. ovularis (Michx.) Torr.—B.2f / C.Gst / D.10.
C. filiculmis Vahl.—B.2f / C.Gst / D.10.
C. dentatus Torr.—B.2f / C.Hsr / D.10.
C. Houghtonii Torr.—B.2f / C.Gst / D.10.
C. Schweinitzii Torr.—B.2f / C.Gst / D.10.
 x *C. mesochorus* Geise.—B.2f / C.Gst / D.10.
C. Engelmanni Steud.—B.① / C.Th / D. 10, 18.
C. strigosus L.—B.2f / C.Gst / D.10.
C. erythrorhizos Muhl.—B.① / C.Th / D. 10, 18.
C. ferruginescens Boeckel.—B.① / C. Th / D. 10, 18.
C. esculentus L.—B.2f / C.Gst / D. 10.
Kyllinga pumila Michx.—B.① / C.Th / D. 10, 18.
Eriophorum spissum Fern.—B.2f / C.Hs / D.10.
E. gracile Koch.—B.2f / C.Grh / D.10.
E. angustifolium Roth.—B.2f / C.Grh / D.10.
E. viridicarinatum (Engelm.) Fern.—B.2f / C.Grh / D.10.
E. virginicum L.—B.2f / C.Hsr / D.10.
Fuirena squarrosa Michx.—B.① / C.Th / D. 10, 18.
Scirpus subterminalis Torr.—B.2f / C.HH / D.10.
S. debilis Pursh.—B.① / C.Th / D. 10, 18.
S. Smithii Gray.—B.① / C. Th / D. 10, 18.
 var. *setosus* Fern.

- S. americanus* Pers.—B. 2f / C.HH / D.10.
S. Torreyi Olney—B. 2f / C.HH / D.10.
S. validus Vahl—B. 2f / C.HH / D.11.
S. acutus Muhl.—B. 2f / C.HH / D.11.
S. fluviatilis (Torr.) Gray—B. 2f / C.HH / D.10.
S. atrovirens Muhl.—B. 2f / C.Hsr / D.10.
 var. *georgianus* (Harper) Fern.
S. polyphyllus Vahl—B. 2f / C.Hsr / D.10.
S. lineatus Michx.—B. 2f / C.Hsr / D.10.
S. cyperinus (L.) Kunth—B. 2f / C.Hsr / D.10.
 var. *Andrewsii* Fern.—var. *pelius* Fern.—var. *condensatus* Fern.
S. pedicellatus Fern.—B. 2f / C.Hsr / D.10.
Eleocharis equisetoides (Ell.) Torr.—B. 2f / C.HH / D.11.
E. quadrangulata var. *crassior* Fern.—B. 2f / C.HH / D.11.
E. Robbinsii Oakes—B. 2f / C.HH / D.11.
E. olivacea Torr.—B. 2f / C. Grh / D.11.
E. caribaea var. *dispar* (E.J.Hill) Blake—B. ① / C.Th / D. 11, 18.
E. ovata (Roth.) R. & S.—B. ① / C.Th / D. 11, 18.
E. reclinata Kunth.—B. ① / C.Th / D. 11, 18.
E. obtusa (Willd.) Schultes—B. ① / C.Th / D. 11, 18.
E. Engelmanni Steud.—B. ① / C.Th / D. 11, 18.
E. Smallii Britt.—B. 2f / C.HH / D.11.
E. calva Torr.—B. 2f / C.Grh / D.11.
E. acicularis var. *typica* Svenson—B. 2f / C.Grh / D.11.
E. Wolfii A. Gray—B. 2f / C.Hsr / D.11.
E. melanocarpa Torr.—B. 2f / C.Hs / D.11.
E. Torreyana Boeckl.—B. ① / C.Th / D. 11, 18.
E. capitata var. *borealis* Svenson—B. 2f / C.Grh / D.11.
 var. *verrucosa* Svenson
E. compressa Sulliv.—B. 2f / C. Grh / D. 11.
 var. *atrata* Svenson
E. rostellata Torr.—B. 2f / C.Hsr / D.11.
E. pauciflora var. *Fernaldii* Svenson—B. 2f / C.Grh / D.11.
Fimbristylis puberula (Michx.) Vahl—B. 2f / C.Grh / D.10.
F. mucronulata (Michx.) Blake—B. ① / C.Th / D. 10, 18.
Stenophyllus capillaris (L.) Britt.—B. ① / C.Th / D. 10, 18.
Psilocarya nitens (Vahl) Wood.—B. ① / C.Th / D. 10, 18.
P. scirpoides Torr.—B. ① / C. Th / D. 10, 18.
Cladium mariscoides (Muhl.) Torr.—B. 2f / C.HH / D.10.
Rhynchospora macrostachya Torr.—B. 2f / C.Hs / D.10.
R. corniculata var. *interior* Fern.—B. 2f / C.Hsr / D.10.
R. cymosa Ell.—B. 2f C.Hs / D.10.
R. alba (L.) Vahl—B. 2f / C.Hs / D.10.
R. capillacea Torr.—B. 2f / C.Hs / D.10.
R. capitellata (Michx.) Vahl—B. 2f / C.Hsr / D.10.
Scleria triglomerata Michx.—B. 2f / C.Grh / D.10.
S. oligantha Michx.—B. 2f / C.Grh / D.10.
S. pauciflora var. *caroliniana* (Willd.) Wood.—B. 2f / C. Grh / D.10.

- S. verticillata* Muhl.—B. 2f / C.Hs / D.10.
S. reticularis Michx.—B. 2f / C.Hs / D.10.
S. setacea Poir.—B. 2f / C.Hs / D.10.
Carex chordorrhiza L.f.—B. 2f / C.Hsr / D.10.
C. Sartwellii Dewey—B. 2f / C. Grh (HH) / D.10.
C. siccata Dewey—B. 2f / C.Grh / D.10.
C. retroflexa Muhl.—B. 2f / C.Hs / D.10.
C. rosea Schkuhr.—B. 2f / C.Hs / D.10.
C. convoluta Mack.—B. 2f / C.Hs / D.10.
C. Muhlenbergii Schkuhr.—B. 2f / C.Grh / D.10.
C. mesochorea Mack.—B. 2f / C.Grh / D.10.
C. cephalophora Muhl.—B. 2f / C.Hs / D.10.
C. Leavenworthii Dewey—B. 2f / C.Grh / D.10.
C. gravida Bailey—B. 2f / C.Grh / D.10.
C. cephaloidea Dewey—B. 2f / C.Grh / D.10.
C. aggregata Mack.—B. 2f / C.Grh / D.10.
C. sparganioides Muhl.—B. 2f / C.Grh / D.10.
C. alopecoidea Tuckerm.—B. 2f / C.Hs / D.10.
C. conjuncta Boott—B. 2f / C.Hs / D.10.
C. vulpinoidea Michx.—B. 2f / C.Grh (HH) / D.10.
C. annectens Bickn.—B. 2f / C.Hs / D.10.
C. diandra Schrank—B. 2f / C.Hs / D.10.
C. prairea Dewey—B. 2f / C.Hs / D.10.
C. decomposita Muhl.—B. 2f / C.Hs / D.10.
C. stipata Muhl.—B. 2f / C.Hs / D.10.
C. laevaginata Kükenth.—B. 2f / C.Hs / D.10.
C. crus-corvi Shuttlw.—B. 2f / C.Hs / D.10.
C. disperma Dewey—B. 2f / C.Grh (HH) / D.10.
C. trisperma Dewey—B. 2f / C.Grh (HH) / D.10.
C. canescens L. var. *disjuncta* Fern.—B. 2f / C.Hs / D.10.
 var. *suloliacea* Laest.
C. bromoides Schkuhr.—B. 2f / C.Hs / D.10.
C. interior Bailey—B. 2f / C.Hs / D.10.
C. Howei Mack.—B. 2f / C.Hs / D.10.
C. sterilis Willd.—B. 2f / C.Hs / D.10.
C. incomperta Bickn.—B. 2f / C.Hs / D.10.
C. laricina Mack.—B. 2f / C.Hs / D.10.
C. seorsa Howe—B. 2f / C.Hs / D.10.
C. scoparia Schkuhr.—B. 2f / C.Hs / D.10.
x *C. fulgida* Hermann—B. 2f / C.Hs / D.10.
C. tribuloides Wahl.—B. 2f / C.Hs / D.10.
C. cristatella Britt.—B. 2f / C.Hs / D.10.
C. muskingumensis Schwein.—B. 2f / C.Grh (HH) / D.10.
C. Bebbii Olney—B. 2f / C.Hs / D.10.
x *C. atacta* Hermann—B. 2f / C.Hs / D.10.
C. straminea Willd.—B. 2f / C.Hs / D.10.
x *C. marcescens* Hermann—B. 2f / C.Hs / D.10.
C. normalis Mack.—B. 2f / C.Hs / D.10.

- C. tenera* Dewey.—B. 2f / C.Hs / D.10.
C. festuceacea Schkuhr.—B. 2f / C.Hs / D.10.
C. molesta Mack.—B. 2f / C.Hs / D.10.
C. brevior (Dewey) Mack.—B. 2f / C.Hs / D.10.
C. Bicknellii Britt.—B. 2f / C.Hs / D.10.
x *C. eurytachys* Hermann.—B. 2f / C.Hs / D.10.
C. Richii (Fern.) Mack.—B. 2f / C.Hs / D.10.
C. suberecta (Olney) Britt.—B. 2f / C.Hs / D.10.
C. alata Torr.—B. 2f / C.Hs / D.10.
C. Longii Mack.—B. 2f / C.Hs / D.10.
C. Willdenovii Schkuhr.—B. 2f / C.Hs / D.10.
C. Jamesii Schwein.—B. 2f / C.Hs / D.10.
C. leptalea Wahl.—B. 2f / CHsr / D.10.
C. pauciflora Lightf.—B. 2f / C.Grh (HH) / D.10.
C. communis Bailey.—B. 2f / C.Hs / D.10.
var. *auriculata* Hermann
C. pennsylvanica Lam.—B. 2f / C.Grh / D.10.
C. heliophila Mack.—B. 2f / C.Hsr / D.10.
C. artilecta Mack.—B. 2f / C.Hs / D.10.
var. *subtilirostris* Hermann
C. albicans Willd.—B. 2f / C.Hs / D.10.
C. nigromarginata Schwein.—B. 2f / C.Hsr / D.10.
C. umbellata Schkuhr.—B. 2f / C.Hsr / D.10.
C. rugosperma Mack.—B. 2f / C.Hs / D.10.
C. tonsa (Fern.) Bickn.—B. 2f / C.Grh / D.10.
C. hirtifolia Mack.—B. 2f / C.Grh / D.10.
C. picta Steud.—B. 2f / C.Grh / D.10.
C. Richardsonii R.Br.—B. 2f / C.Grh / D.10.
C. eburnea Boott.—B. 2f / C.Grh / D.10.
C. Garberi Fern.—B. 2f / C.Grh / D.10.
C. aurea Nutt.—B. 2f / C.Grh / D.10.
C. Meadii Dewey.—B. 2f / C.Grh (HH) / D.10.
C. tetanica Dewey.—B. 2f / C.Grh / D.10.
C. Woodii Dewey.—B. 2f / C.Grh / D.10.
C. plantaginea Lam.—B. 2f / C.Hs / D.10.
C. Careyana Torr.—B. 2f / C.Hs / D.10.
C. platyphylla Carey.—B. 2f / C.Hs / D.10.
C. abscondita Mack.—B. 2f / C.Hs / D.10.
C. digitalis Willd.—B. 2f / C.Hs / D.10.
C. laxiculmis Schwein.—B. 2f / C.Hs / D.10.
C. albusina Sheldon.—B. 2f / C.Hs / D.10.
C. blanda Dewey.—B. 2f / C.Hs / D.10.
C. gracilescens Steud.—B. 2f / C.Hs / D.10.
C. laxiflora Lam.—B. 2f / C.Hs / D.10.
C. styloflexa Buckley.—B. 2f / C.Grh / D.10.
C. granularis Muhl.—B. 2f / C.Hs / D.10.
var. *Haleana* (Olney) Porter—var. *recta* Dewey
C. Crawei Dewey.—B. 2f / C.Grh / D.10.

- C. oligocarpa* Schkuhr.—B. 2f / C.Hs / D.10.
C. Hitchcockiana Dewey.—B. 2f / C.Hs / D.10.
C. conoidea Schkuhr.—B. 2f / C.Hs / D.10.
C. amphibola Steud.—B. 2f / C.Hs / D.10.
C. grisea Wahl.—B. 2f / C.Hs / D.10.
C. glaucoidea Tuckerm.—B. 2f / C.Hs / D.10.
C. gracillima Schwein.—B. 2f / C.Grh / D.10.
C. prasina Wahl.—B. 2f / C.Hs / D.10.
C. Davisii Schwein. & Torr.—B. 2f / C.Grh / D.10.
C. debilis Michx.—B. 2f / C.Hs / D.10.
 var. *Rudgei* Bailey
C. Sprengelii Dewey.—B. 2f / C.Grh / D.10.
C. Swanii (Fern.) Mack.—B. 2f / C.Hs / D.10.
C. virescens Muhl.—B. 2f / C.Hs / D.10.
C. caroliniana Schwein.—B. 2f / C.Grh / D.10.
C. hirsutella Mack.—B. 2f / C.Grh / D.10.
C. Bushii Mack.—B. 2f / G.Hs / D.10.
C. limosa L.—B. 2f / C.Grh (HH) / D.10.
C. Buxbaumii Wahl.—B. 2f / C.Hsr / D.10.
C. Shortiana Dewey.—B. 2f / C.Hs / D.10.
x *C. Deamii* Hermann.—B. 2f / C.Hs / D.10.
C. stricta Lam.—B. 2f / C.Hsr / D.10.
 var. *strictior* (Dewey) Carey
C. Haydeni Dewey.—B. 2f / C.Hsr / D.10.
C. Emoryi Dewey.—B. 2f / C.Grh (HH) / D.10.
C. torta Boott.—B. 2f / C.Hs / D.10.
C. substricta (Kükenth.) Mack.—B. 2f / C.Grh (HH) / D.10.
C. crinita Lam.—B. 2f / C.Hsr / D.10.
 var. *gynandra* Schwein. & Torr.
C. lacustris Willd.—B. 2f / C.Grh (HH) / D.10.
C. hyalinolepis Steud.—B. 2f / C.Grh (HH) / D.10.
x *C. subimpressa* Clokey.—B. 2f / C.Grh / D.10.
C. lanuginosa Michx.—B. 2f / C.Grh (HH) / D.10.
C. lasiocarpa Ehrh.—B. 2f / C.Grh (HH) / D.10.
C. trichocarpa Muhl.—B. 2f / C.Grh (HH) / D.10.
C. atherodes Spreng.—B. 2f / C.Grh (HH) / D.10.
C. viridula Michx.—B. 2f / C.Hs / D.10.
 var. *chlorophila* (Mack.) Hermann
C. cryptolepis Mack.—B. 2f / C.Hs / D.10.
C. flava L.—B. 2f / C.Hs / D.10.
C. folliculata L.—B. 2f / C.Hs / D.10.
C. vesicaria L.—B. 2f / C.Grh (HH) / D.10.
C. rostrata Stokes.—B. 2f / C.Grh (HH) / D.10.
C. Tuckermani Dewey.—B. 2f / C.Grh (HH) / D.10.
C. retrorsa Schwein.—B. 2f / C.Hs / D.10.
C. oligosperma Michx.—B. 2f / C.Grh (HH) / D.10.
C. lurida Wahl.—B. 2f / C.Hs / D.10.
C. hystricina Muhl.—B. 2f / C.Hsr / D.10.

- C. Pseudo-Cyperus* L.—B. 2f / C.Hs / D.10.
C. comosa Boott.—B. 2f / C.Hs / D.10.
C. Frankii Kunth.—B. 2f / C.Hsr / D.10.
C. squarrosa L.—B. 2f / C.Hs / D.10.
C. typhina Michx.—B. 2f / C.Hs / D.10.
C. intumescens Rudge.—B. 2f / C.Hs / D.10.
 var. *Fernaldii* Bailey
C. Grayi Carey.—B. 2f / C.Hs / D.10.
C. louisianica Bailey.—B. 2f / C.GrH (HH) / D.10.
C. lupulina Muhl.—B. 2f / C.Hsr / D.10.
C. lupuliformis Sartwell.—B. 2f / C.Hsr / D.10.
C. gigantea Rudge.—B. 2f / C.Hsr / D.10.

11. *Araceae*

- A. Genes*: 5. *Species*: 7. B. 2f / 7. C. G/4, HH/3. D. 16/3, 17/4.
Acorus Calamus L.—B. 2f / C.HH / D.16.
Symplocarpus foetidus (L.) Nutt.—B. 2f / C.GrH / D.17.
Calla palustris L.—B. 2f / C.HH / D.16.
Peltandra virginica (L.) Kunth.—B. 2f / C.HH / D.16.
Arisaema Dracontium (L.) Schott.—B. 2f / C.Gst / D.17.
A. pusillum (Peck) Nash.—B. 2f / C.Gst / D.17.
A. triphyllum (L.) Schott.—B. 2f / C.Gst / D.17.—(Pl. 3, Figs. 22-24)

12. *Lemnaceae*

- A. Genera*: 4. *Species*: 10. B. 2f / 10. C. HH/10. D. 19/10.
Spirodela polyrrhiza (L.) Schleid.—B. 2f / C.HH / D.19.
Lemna trisulca L.—B. 2f / C.HH / D.19.
L. minor L.—B. 2f / C.HH / D.19.
L. minima Philippi.—B. 2f / C.HH / D.19.
L. perpusilla Torr.—B. 2f / C.HH / D.19.
L. cyclostasa (Ell.) Chev.—B. 2f / C.HH / D.19.
Wolffia columbiana Karst.—B. 2f / C.HH / D.19.
W. papulifera Thompson.—B. 2f / C.HH / D.19.
W. punctata Griseb.—B. 2f / C.HH / D.19.
Wolffiella floribunda (J.D.Smith) Thompson.—B. 2f / C.HH / D.19.

13. *Xyridaceae*

- A. Genera*: 1. *Species*: 2. B. 2f / 2. C. H/2. D. 14/2.
Xyris torta J. E. Smith.—B. 2f / C.Hr / D.14.
X. caroliniana Walt.—B. 2f / C.Hr / D.14.

14. *Eriocaulaceae*

- A. Genes*: 1. *Species*: 1. B. 2f / 1. C. HH/1. D. 19/1.
Eriocaulon septangulare With.—B. 2f / C. HH / D.19.

15. *Commelinaceae*

- A. Genera*: 2. *Species*: 8. B. ①/2, 2f/6. C. H/6, Th/2. D. 16/6, 18/2.
Commelina communis L.—B. ① / C.Th / D. 18.
 var. *verticillata* Peattie
C. longicaulis Jacq.—B. ① / C.Th / D.18.
C. virginica L.—B. 2f / C.Hp / D.16.

- C. angustifolia* Michx.—B. 2f / C.Hp / D.16.
C. erecta L.—B. 2f / C.Hp / D.16.
Tradescantia canaliculata Raf.—B. 2f / C.Hp / D.16.
 f. *albiflora* Slavin & Nieuwl.—f. *Lesteri* Standley—f. *Mariae* Standley
T. subaspera Ker-Gawl. var. *typica* Andrs. & Wood B. 2f / C.Hp / D.16.
T. virginica L.—B. 2f / C.Hp / D.16.

16. *Pontederiaceae*

- A. Genera: 2. Species: 3. B. 2f / 3. C. HH / 3. D. 16 / 2, 19 / 1.
Pontederia cordata L.—B. 2f / C.HH / D.16.
Heteranthera reniformis R.&P.—B. 2f / C.HH / D.16.
H. dubia (Jacq.) MacM.—B 2f / C.HH / D.19.

17. *Juncaceae*

- A. Genera: 2. Species: 25. B. 2f / 24, ① / 1. C. H / 14, G / 10, Th / 1. D. 11 / 3, 10 / 22, 18 / 1.
Juncus acuminatus Michx.—B. 2f C.Hs / D.10.
 f. *obtusatus* Hermann
J. alpinus Vill. var. *rariflorus* Hartm.—B. 2f / C.Grh / D.10.
J. articulatus L.—B. 2f / C.Grh / D.10.
J. balticus Willd. var. *littoralis* Engelm.—B. 2f / C.Grh / D.11.
 f. *disitiflorus* Engelm.
J. brachycarpus Engelm.—B. 2f / C.Grh / D.10.
J. brachycephalus (Engelm.) Buchenau—B. 2f / C.Hs / D.10.
B. brevicaudatus (Engelm.) Fern.—B. 2f / C.Hs / D.10.
J. bufonius L.—B. ① / C.Th / D. 11, 18.
J. canadensis J. Gay—B. 2f / C.Grh / D.10.
J. diffusissimus Buckley—B. 2f / C.Hs / D.10.
J. Dudleyi Wieg.—B. 2f / C.Hr / D.10.
J. efusus L. var. *Pylaei* (La Harpe) Fern. & Wieg.—B. 2f / C.Hr / D.11.
J. Gerardi Loisel.—B. 2f / C.Grh / D.10.
J. Greenei Oakes & Tuckerm.—B. 2f / C.Hr / D.10.
J. interior Wieg.—B. 2f / C.Hr / D.10.
J. marginatus Rostk.—B. 2f / C.Hs / D.10.
J. nodosus L.—B. 2f / C.Gst / D.10.
J. nodatus Cov. B. 2f / C.Hs / D.10.
J. pelocarpus Mey.—B. 2f / C.Grh / D.10.
J. scirpoides Lam.—B. 2f / C.Grh / D.10.
J. secundus Beauv.—B. 2f / C.Hr / D.10.
J. Torreyi Cov.—B. 2f / C.Gst / D.10.
J. macer S. F. Gray—B. 2f / C.Hr / D.10.
 f. *anthelatus* (Wieg.) Hermann—f. *moniliformis* Hermann
 f. *monostichus* (Bartlett) Hermann—f. *Williamsii* (Fern.) Hermann
Luzula campestris (L.) DC. var. *bulbosa* Wood.—B. 2f / C.Hs / D.10.
 var. *multiflora* (Ehrh.) Celak.
L. saltuensis Fern.—B. 2f / C.Hsr / D.10.

18. *Liliaceae*

A. Genera: 25. Species: 49. B. $\frac{1}{2}$ / 4, 2f / 45. C. M / 4, Ch / 1, H / 2, G / 42.
D. 5 / 4, 7 / 4, 9 / 1, 15 / 2, 16 / 1, 17 / 42.

- Tofieldia glutinosa* (Michx.) Pers.—B. 2f / C.Grh / D.17.
Chamaelirium luteum (L.) Gray—B. 2f / C.Grh / D.17.
Stenanthium gramineum (Ker) Morong—B. 2f / C.Gb / D.17.
Zigadenus chloranthus Richards.—B. 2f / D.Gb / D.17.
Melanthium virginicum L.—B. 2f / C. Grh / D.17.
Veratrum Woodii Robbins—B. 2f / C.Grh / D.17.
Uvularia grandiflora J.E.Smith—B. 2f / C.Grh / D.17.
U. sessilifolia L.—B. 2f / C.Grh / D.17.
Allium tricoccum Ait.—B. 2f / C.Gb / D.17.
**A. vineale* L. B. 2f / C.Gb / D.17.
**A. sativum* L.—B. 2f / C.Gb / D.17.
A. canadense L.—B. 2f / C.Gb / D.17.
A. cernuum Roth.—B. 2f / C.Gb / D.17.
Nothoscordum bivalve (L.) Britt.—B. 2f / C.Gb / D.17.
**Hemerocallis fulva* L.—B. 2f / C.Gr / D.17.
Lilium philadelphicum var. *andinum* (Nutt.) Ker—B. 2f / C.Gb / D.17.
L. superbum L.—B. 2f / C.Gb / D.17.
L. canadense L.—B. 2f / C.Gb / D.17.
L. michiganense Farwell—B. 2f / C.Gb / D.17.
**L. tigrinum* L.—B. 2f / C.Gb / D.17.
Erythronium albidum Nutt.—B. 2f / C.Gb / D.17.
E. americanum Ker—B. 2f / C.Gb / D.17.

The bulb produces bulbiferous stolons, a rare occurrence.

- Camassia hyacinthina* (Ker) Palmer & Steyermark—B. 2f / C.Gb / D.17.
**Ornithogalum umbellatum* L.—B. 2f / C.Gb / D.17.
**Muscari botryoides* (L.) Mill.—B. 2f / C.Gb / D.17.
**M. racemosum* (L.) Mill.—B. 2f / C.Gb / D.17.
**Yucca filamentosa* L.—B. 2f / C.Ch / D.9.
**Asparagus officinalis* L.—B. 2f / C.Grh / D.17.
Clintonia borealis (Ait.) Raf.—B. 2f / C.Grh / D.17.
Smilacina racemosa (L.) Desf.—B. 2f / C.Grh / D.17.
S. stellata (L.) Desf. B. 2f / C.Grh / D.17.
Maianthemum canadense Raf. B. 2f / C.Hpr. / D.16.
 var. *interius* Fern.
Polygonatum pubescens (Willd.) Pursh—B. 2f / C.Grh / D.17.
P. biflorum (Walt.) Ell.—B. 2f / C.Grh / D.17.
Medeola virginiana L.—B. 2f / C.Grh / D.17.
Trillium sessile L.—B. 2f / C.Grh / D.17.
 f. *luteum* (Muhl.) Peattie
T. recurvatum Beck—B. 2f / C.Grh / D.17.
 f. *luteum* Clute
T. nivale Riddell—B. 2f / C.Grh / D.17.
T. grandiflorum (Michx.) Salisb.—B. 2f / C.Grh / D.17.
T. cernuum var. *macranthum* Eames & Wieg.—B. 2f / C.Grh / D.17.

- T. Gleasoni* Fern.—B. 2f / C.Grh / D.17.
 f. *Walpolei* (Farwell) Deam
Aletris farinosa L.—B. 2f / C.Grh / D.17.
Smilax herbacea L.—B. 2f / C.Hpr / D.15.
 var. *lasioneuron* (Hook.) A. DC.
S. pulverulenta Michx.—B. 2f / C.Hpr / D. 15, 17.
S. ecirrhata (Engelm.) Wats.—B. 2f / C.Grh / D.17.
S. glauca var. *genuina* Blake—B. ½ / C.M / D. 5, 7.
S. Bona-nox L. —B. ½ / C.M / D. 5, 7.
S. rotundifolia L.—B. ½ / C.M / D. 5, 7.
S. hispida Muhl.—B. ½ / C.M / D. 5, 7.

19. *Amaryllidaceae*

- A. Genera: 3. Species 3. B. 2f / 3. C. G/3. D. 17/3.
Hymenocallis occidentalis (LeConte) Kunth—B. 2f / C.Gb / D.17.
Agave virginica L.—B. 2f / C.Gb / D.17.
Hypoxis hirsuta (L.) Cov.—B. 2f / C.Gst / D.17.

20. *Dioscoreaceae*

- A. Genera: 1. Species: 4. B. 2f / 4. C. G/4. D. 15/4, 17/4.
Dioscorea hirticaulis Bartlett—B. 2f / C.Grh / D. 15, 17.
D. glauca Muhl.—B. 2f / C.Grh / D. 15, 17.
D. paniculata Michx.—B. 2f / C.Grh / D. 15, 17.—(Pl. 3, Figs. 25-27).
D. quaternata (Walt.) Gmel.—B. 2f / C.Grh / D. 15, 17.

21. *Iridaceae*

- A. Genera: 3. Species: 8. B. 2f / 8. C. H/4, G/4. D. 16/4, 17/4.
Iris cristata Ait.—B. 2f / C.Grh / D.17.
I. foliosa Mack. & Bush—B. 2f / C.Grh / D.17.
I. virginica var. *Schrevei* (Small) Anders. L.—B. 2f / C.Grh / D.17.
**Belamcanda chinensis* (L.) DC.—B. 2f / C.Grh / D.17.
Sisyrinchium albidum Raf.—B. 2f / C.Hsr / D.16.
S. angustifolium Mill.—B. 2f / C.Hsr / D.16.
S. graminoides Bicknell—B. 2f / C.Hsr / D.16.
S. atlanticum Bicknell—B. 2f / C.Hsr / D.16.

22. *Orchidaceae*

- A. Genera: 17. Species: 40. B. 2f / 40. C. H/8, G/32. D. 14/5, 16/3, 17/32, 20/4.
Cypripedium Reginae Walt.—B. 2f / C.Grh / D.17.
C. candidum Muhl.—B. 2f / C.Grh / D.17.
C. parviflorum Salisb.—B. 2f / C.Grh / D.17.
 var. *pubescens* (Willd.) Knight
C. acaule Ait.—B. 2f / C.Grh / D.17.
Orchis spectabilis L.—B. 2f / C. Grt / D.17.
Habenaria viridis var. *bracteata* (Muhl.) Gray—B. 2f / C.Grt / D.17.
H. flava (L.) Gray—B. 2f / C.Grt / D.17.

- H. scutellata* (Nutt.) Morris.—B. 2f / C.Grt / D.17.
H. dilatata (Pursh) Gray.—B. 2f / C.Grt / D.17.
H. hyperborea (L.) R.Br.—B. 2f / C.Grt / D.17.
H. clavellata (Michx.) Spreng.—B. 2f / C.Grt / D.17.
H. orbiculata (Pursh) Torr.—B. 2f / C.Grt / D.17.
H. Hookeri Torr.—B. 2f / C.Grt / D.17.
H. ciliaris (L.) R.Br.—B. 2f / C.Grt / D.17.
H. lacera (Michx.) R.Br.—B. 2f / C.Grt / D.17.
H. leucophaea (Nutt.) Gray.—B. 2f / C.Grt / D.17.
H. psycodes (L.) Spreng.—B. 2f / C.Grt / D.17.
H. peramoena Gray.—B. 2f / C.Grt / D.17.
Pogonia ophioglossoides (L.) Ker.—B. 2f / C.Gr / D.17.
Triphora trianthophora (Sw.) Rydb.—B. 2f / C.Grt / D.17.
Isotria verticillata (Willd.) Raf.—B. 2f / C.Gr / D.17.
Arethusa bulbosa L.—B. 2f / C.Gst / D.17.
**Epipactis latifolia* (Huds.) All.—B. 2f / C.Gr / D.17.
Spiranthes Beckii Lindl.—B. 2f / C.Hr / D.14.
S. gracilis (Bigel.) Beck.—B. 2f / C.Hr / D.14.
S. lucida (H.H.Eaton) Ames.—B. 2f / C.Hs / D.16.
S. ovalis Lindl.—B. 2f / C.Hs / D.16.
S. cernua (L.) Richard.—B. 2f / C.Hs / D.16.
Goodyera pubescens R.Br.—B. 2f / C.Hrr / D.14.
Calopogon pulchellus (Salisb.) R.Br.—B. 2f / C.Gst / D.17.
Corallorrhiza trifida Chatelain.—B. 2f / C.Gr / D.17, 20.
C. Wisteriana Conrad.—B. 2f / C.Gr / D. 17, 20.
C. maculata Raf.—B. 2f / C.Gr / D. 17, 20.
C. odororhiza Nutt.—B. 2f / C.Gr / D. 17, 20.
Malaxis unifolia Michx.—B. 2f / C.Gst / D.17.
Liparis liliifolia (L.) Richard.—B. 2f / C.Hr / D.14.
L. Loeselii (L.) Richard.—B. 2f / C.Hr / D.14.
Tipularia discolor (Pursh) Nutt.—B. 2f / C.Gst / D.17.
Hexaletris spicata (Walt.) Barnh.—B. 2f / C. Gr / D.17.
Aplectrum hyemale (Muhl.) Torr.—B. 2f / C.Gst / D.17.

DICOTYLEDONAE

Families: 111. A. Genera: 506. Species: 1460.

- B. 1/134, 2/175(+3), 2f/784, ②/94(+12), ①/273(+41).
 C. MM/114(+4), M/112(+4), N/60(+5), E/1, S/1, Ch/40(+1), H/733
 D. 2/133(+4), 3/7, 4/130(+4), 5/36(+1), 7/79, 9/19, 12/27, 14/63, 15/31,
 16/627, 17/82, 18/273, 19/31, 20/10.

23. Saururaceae

- A. Genera: 1. Species: 1. B. 2f/1. C. HH/1. D. 16/1.
Saururus cernuus L.—B. 2f / C.HH/ D.16.

24. Salicaceae

- A. Genera: 2. Species: 25. B. 1/10, 2/15. C. MM/10 (+1), M/7 (+3),
 N/8 (+2). D. 2/10 (+4), 4/15.

- **Populus alba* L.—B. h / C.MM / D.2.
P. heterophylla L.—B h / C.MM / D.2.
P. deltoides Marsh.—B. h / C.MM / D.2.
 var. *candicans* (Ait.) Stout
P. deltoides Marsh.—B. h / C.MM D.2.
P. grandidentata Michx.—B h / C.MM / D.2.
P. tremuloides Michx.—B. h / C.MM / D.2.
Salix nigra Marsh.—B. h / C.MM / D.2.
S. amygdaloides Anders.—B. h / C.M (MM) / D.2.
S. serissima (Bailey) Fern.—B. h / C.M / D.4.
S. lucida Muhl.—B. h (h) / C.M (N) / D.4 (2).
 var. *intonsa* Fern.
S. longipes Shuttlw.—B. h / C.M (N) / D.4.
 **S. alba* L.—B. h / C.MM (M) / D.2.
 *var. *vitellina* (L.) Koch
 **S. fragilis* L.—B. h / C.MM / D.2.
S. longifolia Muhl.—B. h / C.M / D.4.
 var. *Wheeleri* (Rowlee) Schneider
S. discolor Muhl.—B. h (h) / C.M / D.4 (2).
 var. *latifolia* (Michx.) Anders.
S. petiolaris J.E.Smith—B. h (h) / C.N (M) / D.4 (2).
S. sericea Marsh.—B. h / C.N / D.4.
S. humilis Marsh.—B. h / C.N / D.4.
S. tristis Ait.—B. h / C.N / D.4.
S. Bebbiana Sarg.—B. h (h) / C.M / D.4 (2).
S. pedicellaris var. *hypoglauca* Fern.—B. h / C.N / D.4.
S. candida Flüge—B. h / C.N / D.4.
 var. *denudata* Anders.
S. adenophylla Hook.—B. h / C.N (M) / D.4.
S. cordata Muhl.—B. h / C.M / D.4.
S. glaucophylla Bebb—B. h / C.N / D.4.

25. *Myricaceae*

- A. Genera: 1. Species: 1. B. h / 1. C. N / 1. D. 4 / 1.
Myrica asplenifolia L.—B. h / C.N. / D.4.

26. *Juglandaceae*

- A. Genera: 2. Species: 10. B. h / 10. C. MM / 10. D. 2 / 10.
Juglans cinerea L.—B. h / C.MM / D.2.
Juglans nigra L.—B. h / C.MM / D.2.
Carya Pecan (Marsh.) Engler. & Graebn.—B. h / C.MM / D.2.
C. cordiformis (Wang.) K.Koch—B. h / C.MM / D.2.
C. ovata (Mill.) K.Koch—B. h / C.MM / D.2.
 var. *fraxinifolia* Sarg.—var. *Nuttallii* Sarg.
C. lacinoso (Michx.f.) Loud.—B. h / C.MM / D.2.
Carya tomentosa Nutt.—B. h / C.MM / D.2.
 var. *subcoriacea* (Sarg.) Palmer & Steyermark

- C. glabra* (Mill.) Sweet.—B. h / C.MM / D.2.
 var. *megacarpa* Sarg.
C. ovalis (Wang.) Sarg.—B. h / C.MM / D.2.
 var. *odorata* (Marsh.) Sarg.—var. *obovalis* Sarg.—var. *obovalis* f. *acuta* Sarg.
 var. *obcordata* Sarg.—var. *obcordata* f. *vestita* Sarg.
C. Buckleyi var. *arkansana* Sarg.—B. h / C.MM / D.2.

27. *Betulaceae*

- A.* Genera: 5. Species: 11. *B.* h / 7, h / 4 (+1). *C.* MM/5 (+2), M/6.
 N/ (1). *D.* 2/7, 4/4 (+1).
Carpinus caroliniana Walt.—B. h / C.M (MM) / D.2.
Ostrya virginiana (Mill.) K.Koch.—B. h / C.M (MM) / D.2.
 var. *glandulosa* (Spach) Sarg.
Corylus americana Walt.—B. h / C.M / D.4.
Betula lutea Michx. f.—B. h / C.MM / D.2.
 var. *macrolepis* Fern.
B. populifolia Marsh.—B. h / C.MM / D.2.
B. papyrifera Marsh.—B. h / C.MM / D.2.
B. nigra L.—B. h / C.MM / D.2.
B. pumila L.—B. h / C.M (N) / D.4.
 var. *glandulifera* Regel.
 x *Betula Purpusii* Schneider.—B. h / C.M / D.4.
Alnus incana var. *americana* Regel.—B. h (h) / C.M / D. 2 (4).
A. rugosa (Ehrh.) Spreng.—B. h / C.M / D.4.

28. *Fagaceae*

- A.* Genera: 3. Species: 26. *B.* h / 26, *C.* MM/25(+1), M/1. *D.* 2/26.
Fagus grandifolia Ehrh.—B. h / C.MM / D.2.
 f. *pubescens* Fern. & Rehder
Castanea dentata (Marsh.) Borkh.—B. h / C.MM / D.2.
Quercus alba L.—B. h / C.MM / D.2.
 var. *latiloba* Sarg.
 x *Q. Beadlei* Trel.—B. h / C.MM / D.2.
 x *Q. Deamii* Trel.—B. h / C.MM / D.2.
 x *Q. Jackiana* Schneider.—B. h / C.MM / D.2.
Q. bicolor Willd.—B. h / C.MM / D.2.
 x *Q. Schuettii* Trel.—B. h / C.MM / D.2.
Q. Muhlenbergii Engelm.—B. h / C.MM / D.2.
Q. prinoides Willd.—B. h / C.M / D.2.
Q. Prinus L.—B. h / C.MM / D.2.
Q. montana Willd.—B. h / C.MM / D.2.
Q. stellata Wang.—B. h / C.MM / D.2.
Q. macrocarpa Michx.—B. h / C.MM / D.2.
 var. *olivaeformis* (Michx.f.) Gray
 x *Q. Hillii* Trel.—B. h / C.MM / D.2.
Q. lyrata Walt.—B. h / C.MM / D.2.
Q. imbricaria Michx.—B. h / C.MM / D.2.
 x *Q. exacta* Trel.—B h / C.MM / D.2.

- x *Q. Leana* Nutt.—B. 1 / C.MM / D.2.
Q. borealis var. *maxima* (Marsh.) Ashe—B. 1 / C.MM / D.2.
Q. velutina Lam.—B. 1 / C.MM / D.2.
Q. palustris Muench.—B. 1 / C.MM / D.2.
Q. Shumardii Buckley—B. 1 / C.MM / D.2.
 var. *Schneekii* (Britt.) Sarg.
Q. ellipsoidalis E.J.Hill—B. 1 / C.MM / D.2.
Q. coccinea Muench.—B. 1 / C.MM / D.2.
Q. falcata Michx.—B. 1 / C.MM / D.2.
 var. *pagodaefolia* Ell.—var. *leucophylla* (Ashe) Palmer & Steyermark
 var. *triloba* (Michx.) Palmer & Steyermark
Q. marilandica Muench.—B. 1 / C.M (MM) / D.2.

29. *Ulmaceae*

- A. Genera:* 2. *Species:* 7. B. 1 / 6, 1 / 1. C. MM / 6, M / 1. D. 2 / 6, 4 / 1.
Ulmus fulva Michx.—B. 1 / C.MM / D.2.
U. racemosa Thomas—B. 1 / C.MM / D.2.
U. alata Michx.—B. 1 / C.MM / D.2.
U. americana L.—B. 1 / C.MM / D.2.
Celtis occidentalis var. *canina* (Raf.) Sarg.—B. 1 / C.MM / D.2.
 var. *crassifolia* (Lam.) Gray
C. laevigata Willd.—B. 1 / C.MM / D.2.
C. pumila (Muhl.) Pursh—B. 1 / C.M / D.4.

30. *Moraceae*

- A. Genera:* 4. *Species:* 6. B. 1 / 3, 2 / 1, ① / 2. C. MM / 3, G / 1, Th / 2.
 D. 2 / 3, 15 / 1, 17 / 1, 18 / 2.
Morus rubra L.—B. 1 / C.MM / D.2.
 **M. alba* var. *tatarica* (L.) Loud.—B. 1 / C.MM / D.2.
 **Maclura pomifera* (Raf.) Schneid.—B. 1 / C.MM / D.2.
 **Humulus japonicus* Sieb. & Zucc.—B. ① / C.Th / D.18.
H. americanus Nutt.—B. 2 / 1 / C.Grh / D. 15, 17.
 **Cannabis sativa* L.—B. ① / C.Th. / D.18.

31. *Urticaceae*

- A. Genera:* 5. *Species:* 7. B. 2 / 4, ① / 3. C. H / 2, G / 2, Th / 3. D. 16 / 2, 17 / 2, 18 / 3.
 **Urtica dioica* L.—B. 2 / 1 / C.Hpr / D.16.
U. procera Muhl.—B. 2 / 1 / C.Hpr / D.16.
Laportea canadensis (L.) Gaud.—B. 2 / 1 / C.Grh / D.17.
Pilea pumila var. *Deamii* (Lunell) Fern.—B. ① / C.Th / D.18.
P. fontana (Lunell) Rydb.—B. ① / C.Th / D.18.
Boehmeria cylindrica (L.) Sw.—B. 2 / 1 / C.Grh / D.17.
 var. *Drummondiana* Weddell
Parietaria pennsylvanica Muhl.—B. ① / C.Th / D.18.

32. *Loranthaceae*

- A. Genera:* 1. *Species:* 1. B. 1 / 1. C. E / 1. D. 3 / 1, 20 / 1.
Phoradendron flavescens (Pursh) Nutt.—B. 1 / C.E. / D.3, 20.

33. *Santalaceae*

A. Genera: 1. Species: 1. B. 2f / 1. C. G/1. D. 17/1, 20/1.

Comandra Richardsiana Fern.—B. 2f / C. Grh / D. 17, 20.

Parasitic at only young stages of development. (Holm, 1924.)

34. *Aristolochiaceae*

A. Genera: 2. Species: 4. B. 2 / 1, 2f / 3. C. MM/1, H/2, G/1. D. 5/1, 14/2, 17/1.

Asarum reflexum Bickn.—B. 2f / C. Hrr / D. 14.

A. canadense L.—B. 2f / C. Hrr / D. 14.

Aristolochia Serpentaria L.—B. 2f / C. Grh / D. 17.

A. tomentosa Sims—B. 2 / C. MM / D. 5.

35. *Polygonaceae*

A. Genera: 4. Species: 32. B. ①/17, 2f / 15. C. H/12, G/1, HH/2, Th/17. D. 7/2, 16/14, 17/1, 18/17.

**Rumex Acetosella* L.—B. 2f / C. Hsr / D. 16.

R. altissimus Wood—B. 2f / C. Hs / D. 16.

R. verticillatus L.—B. 2f / C. Hs / D. 16.

R. triangulivalvis (Danser) Rech. f.—B. 2f / C. Hs / D. 16.

R. Britannica L.—B. 2f / C. Hs / D. 16.

**R. crispus* L.—B. 2f / C. Hs / D. 16.

**R. obtusifolius* L.—B. 2f / C. Hs / D. 16.

Polygonum exsertum Small—B. ① / C. Th / D. 18.

P. erectum L.—B. ① / C. Th / D. 18.

**P. monspeliense* Theibaud—B. ① / C. Th / D. 18.

P. buxiforme Small—B. ① / C. Th / D. 18.

P. aviculare L.—B. ① / C. Th / D. 18.

P. neglectum Besser—B. ① / C. Th / D. 18.

P. tenue Michx.—B. ① / C. Th / D. 18.

P. natans f. *genuinum* Stanford—B. 2f / C. HH / D. 16.

f. *Hartwrightii* (Gray) Stanford.

P. coccineum Muhl.—B. 2f / C. HH / D. 16.

P. pennsylvanicum var. *genuinum* Fern.—B. ① / C. Th / D. 18.

var. *laevigatum* Fern.

f. *pallescens* Stanford

**P. lapathifolium* L.—B. ① / C. Th / D. 18.

P. Carey Olney—B. ① / C. Th / D. 18.

P. Hydropiper var. *projectum* Stanford—B. ① / C. Th / D. 18.

P. punctatum Ell.—B. ①, 2f / C. Hp / D. 16.

**P. Persicaria* L.—B. ① / C. Th / D. 18.

P. hydropiperoides Michx.—B. 2f / C. Hp / D. 16.

var. *strigosum* (Small) Stanford

**P. orientale* L.—B. ① / C. Th / D. 18.

P. virginianum L.—B. 2f / C. Grh / D. 17.

P. arifolium var. *lentiforme* Fern. & Griscom—B. 2f / C. Hp / D. 7, 16.

P. sagittatum L.—B. ① / C. Th / D. 7, 18.

- **P. Convolvulus* L.—B.① / C.Th / D.18.
P. dumetorum L.—B.2f / C.Hp / D.16.
P. scandens L.—B.2f / C.Hp / D.16.
 **Fagopyrum esculentum* Moench.—B.① / C.Th / D.18.
Polygonella articulata (L.) Meisn.—B.① / C.Th / D.18.

36. *Chenopodiaceae*

- A.* Genera: 5. Species: 19. *B.* 2f / 1, ① / 18. *C.* H / 1, Th / 18. *D.* 16 / 1, 18 / 18.
Cycloloma atriplicifolium (Spreng.) Coult.—B.① / C.Th / D.18.
 **Chenopodium ambrosioides* L.—B.2f, ① / C.Hp / D.16.
 **C. Botrys* L.—B.① / C.Th / D.18.
C. capitatum (L.) Asch.—B.① / C.Th / D.18.
 **C. glaucum* L.—B.① / C.Th / D.18.
C. gigantospermum Aellen.—B.① / C.Th / D.18.
 var. *Standleyanum* Aellen—f. *Griffithsii* Aellen
 **C. album* L.—B.① / C.Th / D.18.
C. Berlandieri Moq.—B.① / C.Th / D.18.
 subsp. *Bosceanum* (Moq.) Aellen
C. Standleyanum Aellen.—B.① / C.Th / D.18.
C. missouriense Aellen.—B.① / C.Th / D.18.
 var. *Bushmanum* Aellen
C. Bushianum Aellen.—B.① / C.Th / D.18.
 f. *acutidentatum* Aellen.
C. leptophyllum Nutt.—B.① / C.Th / D.18.
 **Chenopodium murale* L.—B.① / C.Th / D.18.
 **C. urbicum* L.—B.① / C.Th / D.18.
 var. *intermedium* (Mert. & Koch) Koch
 **Atriplex rosea* L.—B.① / C.Th / D.18.
A. patula L.—B.① / C.Th / D.18.
 var. *hastata* (L.) Gray
 var. *littoralis* (L.) Gray
Corispermum nitidum Kit.—B.① / C.Th / D.18.
C. hyssopifolium L.—B.① / C.Th / D.18.
Salsola pestifer A. Nelson.—B.① / C.Th / D.18.

37. *Amaranthaceae*

- A.* Genera: 5. Species: 13. *B.* 2f / 1, ① / 12. *C.* H / 1, Th / 12. *D.* 16 / 1, 18 / 12.
 **Celosia argentea* L.—B.① / C.Th / D.18.
 **Amaranthus cruentus* L.—B.① / C.Th / D.18.
 **A. hybridus* L.—B.① / C.Th / D.18.
 **A. retroflexus* L.—B.① / C.Th / D.18.
 **A. spinosus* L.—B.① / C.Th / D.18.
A. blitoides S. Wats.—B.① / C.Th / D.18.
A. graecizans L.—B.① / C.Th / D.18.
Acnida tamariscina (Nutt.) Wood.—B.① / C.Th / D.18.
A. altissima Riddell.—B.① / C.Th / D.18.
A. subnuda (S.Wats.) Standley.—B.① / C.Th / D.18.

**Froelichia gracilis* (Hook.) Moq.—B.① / C.Th / D.18.

**F. campestris* Small—B.① / C. Th / D.18.

Iresine rhizomatosa Standley—B.2f / C.Hp / D.16.

38. Nyctaginaceae

A. Genera: 1. Species: 1. B. 2f / 1. C. G/1. D. 17/1.

Oxyhaphus nyctagineus (Michx.) Sweet—B.2f / C. Grt / D.17.

39. Phytolaccaceae

A. Genera: 1. Species: 1. B. 2f / 1. C. G/1. D. 17/1.

Phytolacca americana L.—B.2f / C.Grt / D.17.—(See Troll, 1935, 168-169).

40. Aizoaceae

A. Genera: 1. Species: 1. B. ①/1. C. Th/1. D. 18/1.

**Mollugo verticillata* L.—B.① / C.Th / D.18.

41. Portulacaceae

A. Genera: 3. Species: 3. B. 2f/2, ①/1. C. H/1, G/1, Th/1. D. 14/1, 17/1, 18/1.

Talinum rugospermum Holz.—B.2f / C.Hr / D.14.

Claytonia virginica L.—B.2f / C.Grt / D.17.—(Pl. 1, Fig. 2).

**Portulaca oleracea* L.—B.① / C.Th / D.18.

42. Caryophyllaceae

A. Genera: 11. Species: 28. B. 2f/13, ②/1(+1), ①/14. C. Ch/5, H/9, Th/14. D. 12/5, 16/9, 18/14.

**Stellaria graminea* L.—B.2f / C.Hpr / D.16.

S. longifolia Muhl.—B.2f / C.Ch / D.12.

S. pubera Michx.—B.2f / C.Ch / D.12.

var. *silvatica* (Beguinot) Weatherby

**S. media* (L.) Cyrill.—B.① / C.Th / D.18.

**Cerastium vulgatum* var. *hirsutum* Fries—B.2f ②, / C.Ch / D.12.

var. *hirsutum* f. *glandulosum* (Boenn.) Druce

C. arvense L.—B.2f / C.Ch / D.12.

**C. viscosum* L.—B.① / C.Th / D.18.

**C. nutans* Raf.—B.① / C.Th / D.18.

Sagina decumbens (Ell.) T.&G.—B.① / C.Th / D.18.

**Arenaria serpyllifolia* L.—B.① / C.Th / D.18.

A. lateriflora L.—B.2f / C.Hpr / D.16.

A. stricta Michx.—B.2f / C.Ch / D.12.

A. patula Michx.—B.① / C.Th / D.18.

Anychia canadensis (L.) BSP.—B.① / C.Th / D.18.

**Scleranthus annuus* L.—B.① / C.Th / D.18.

**Agrostemma Githago* L.—B.① / C.Th / D.18.

Silene stellata (L.) Ait.f.—B.2f / C.Hs / D.16.

S. nivea (Nutt.) Oth.—B.2f / C.Hp / D.16.

**S. Cucubalus* Wibel.—B.2f / C.Hpr / D.16.

**S. dichotoma* Ehrh.—B.① / C.Th / D.18.

- S. antirrhinna* L.—B.① / C.Th / D.18.
 **S. noctiflora* L.—B.① / C.Th / D.18.
S. regia Sims.—B. 2f / C.Hp / D.16.
S. virginica L.—B. 2f / C.Hs / D.16.
 **Lychnis alba* Mill.—B.② / C.Hs / D.16.
 **Dianthus Armeria* L.—B.① / C.Th / D.18.
 **Saponaria officinalis* L.—B. 2f / C.Hpr / D.16.
 **S. Vaccaria* L.—B.① / C.Th / D.18.

43. *Nymphaeaceae*

- A.* Genera: 5. Species: 6. B. 2f / 6. C. HH / 6. D. 19 / 6.
Nelumbo pentapetala (Walt.) Fern.—B. 2f / C.HH / D.19.
Cabomba caroliniana Gray.—B. 2f / C.HH / D.19.
Brasenia Schreberi Gmel.—B. 2f / C.HH / D.19.
Nymphaea tuberosa Paine.—B. 2f / C.HH / D.19.
Nuphar advenum Ait.—B. 2f / C.HH / D.19.

44. *Ceratophyllaceae*

- A.* Genera: 1. Species: 1. B. 2f / 1. C. HH / 1. D. 19 / 1.
Ceratophyllum demersum L.—B. 2f / C.HH / D.19.

45. *Ranunculaceae*

- A.* Genera: 17. Species: 45. B. 1/3, 2f/36, ①/6. C. M/3, H/25, G/8, HH/3, Th/6. D. 5/3, 14/3, 16/22, 17/8, 18/6, 19/3.
Hydrastis canadensis L.—B. 2f / C.Grh / D.17.
Caltha palustris L.—B. 2f / C.Hs / D.16.
Isopyrum biternatum (Raf.) T.&G. B. 2f / C.Hsr / D.16.
Coptis groenlandica (Oeder) Fern.—B. 2f / C.Hrr / D.14.
Actaea alba (L.) Mill.—B. 2f / C.Grh / D.17.
A. rubra (Ait.) Willd.—B. 2f / C.Grh / D.17.
Cimicifuga racemosa (L.) Nutt.—B. 2f / C.Grh / D.17.—(Pl. 4, Fig. 28).
Aquilegia canadensis L.—B. 2f / C.Hs / D.16.
 **Delphinium Ajacis* L.—B.① / C.Th / D.18.
D. tricornis Michx.—B. 2f / C.Hs / D.16.
Aconitum uncinatum L.—B. 2f / C.Hsr / D.16.
Anemone quinquefolia var. *interior* Fern.—B. 2f / C.Grh / D.17.
A. caroliniana Walt.—B. 2f / C.Gst / D.17.
A. canadensis L.—B. 2f / C.Hs / D.16.
A. cylindrica Gray.—B. 2f / C.Hs / D.16.
A. virginiana L.—B. 2f / C.Hs / D.16.
Anemonella thalictroides (L.) Spach.—B. 2f / C.Grt / D.17.
Hepatica acutiloba DC.—B. 2f / C.Hr / D.14.
H. americana (DC.) Ker.—B. 2f / C.Hr / D.14.
Clematis Viorna L.—B. 1/2 / C. M / D.5.
C. Pitcheri T.&G.—B. 1/2 / C. M / D.5.
C. virginiana L.—B. 1/2 / C. M / D.5.
 **Myosurus minimus* L.—B.① / C.Th / D.18.
Trautvetteria carolinensis (Walt.) Vail.—B. 2f / C.Grh / D.17.

- Ranunculus flabellaris* Raf.—B. 2f / C.HH / D.19.
R. trichophyllus Chaix.—B. 2f / C.HH / D.19.
R. longirostris Godr.—B. 2f / C.HH / D.19.
R. pusillus Poir.—B. ① / C.Th / D.18.
R. oblongifolius Ell.—B. ① / C.Th / D.18.
R. ambigens Wats.—B. 2f / C.Hsr / D.16.
R. abortivus L.—B. 2f / C.Hs / D.16.—(Pl. 2, Figs. 17, 18; Pl. 3, Fig. 18).
R. sceleratus L.—B. ① / C.Th / D.18.
R. micranthus Nutt.—B. 2f / C.Hs / D.16.
**R. bulbosus* L.—B. 2f / C.Hs / D.16.
R. recurvatus Poir.—B. 2f / C.Hs / D.16.
**R. acris* L.—B. 2f / C.Hs / D.16.
R. fascicularis Muhl.—B. 2f / C.Hs / D.16.
R. pennsylvanicus L.f.—B. ① / C.Th / D.18.
**R. repens* var. *villosus* Lamotte.—B. 2f / C.Hsr / D.16.
R. hispidus Michx.—B. 2f / C.Hs / D.16.
R. septentrionalis Poir.—B. 2f / C.Hsr / D.16.
 var. *caricetorum* (Greene) Fern.
Thalictrum dioicum L.—B. 2f / C.Hs / D.16.
T. revolutum D.C.—B. 2f / C.Hs / D.16.
T. dasycarpum Fisch. & Lall.—B. 2f / C.Hs / D.16.
T. polygamum Muhl.—B. 2f / C.Hs / D.16.

46. *Berberidaceae*

- A. Genera: 4. Species: 6. B. 1/3, 2f/3. C. G/3, M/2, N/1. D. 4/3, 7/3, 17/3.
Podophyllum peltatum L.—B. 2f / C.Grh / D.17.—(Pl. 5, Figs. 37-40).
 f. *aphyllum* Plitt.
Caulophyllum thalictroides (L.) Michx.—B. 2f / C.Grh / D.17.
Jeffersonia diphylla (L.) Pers.—B. 2f / C.Grh / D.17.
**Berberis Thunbergii* DC.—B. 1/3 / C.M / D. 4, 7.
**B. vulgaris* L.—B. 1/3 / C.M / D. 4, 7.
**B. canadensis* Mill.—B. 1/3 / C.N / D. 4, 7.

47. *Menispermaceae*

- A. Genera: 3. Species: 3. B. 2f/1, 1/3. C. M/3, Ch/1. D. 5/3, 9/1.
Menispermum canadense L.—B. 2f, 1/3 / D.Ch, M/ D. 5, 9.
 Herbaceous in northern part of state; often woody vine in lower Wabash valley.
 (Deam 1932.)
Cocculus carolinus (L.) DC.—B. 1/3 / C.M / D.5.
Calycocarpum Lyoni (Pursh) Nutt.—B. 1/3 / C.M / D.5.

48. *Magnoliaceae*

- A. Genera: 2. Species: 2. B. 1/2. C. MM/2. D. 2/2.
Magnolia acuminata L.—B. 1/3 / C.MM / D.2.
Liriodendron Tulipifera L.—B. 1/3 / C.MM / D.2.

49. *Anonaceae*

- A.* Genera: 1. Species: 1. *B.* 1/1. *C.* M/1. *D.* 2/1.
Asimina triloba (L.) Dunal—*B.* 1 / C.M / D.2.

50. *Lauraceae*

- A.* Genera: 2. Species: 2. *B.* 1/1, 1/1. *C.* MM/1, M/1. *D.* 2/1, 4/1.
S. albidum (Nutt.) Nees—*B.* 1 / C.MM / D.2.
 var. *molle* (Raf.) Fern.
Benzoin aestivale (L.) Nees—*B.* 1/2 / C.M / D.4.

51. *Papaveraceae*

- A.* Genera: 3. Species: 3. *B.* 21/2, 2/1. *C.* H/2, G/1. *D.* 16/2, 17/1.
Sanguinaria canadensis L.—*B.* 21 / C.GrH / D.17.—(Pl.3, Figs. 19, 20; Pl. 5, Fig. 41.)
Stylophorum diphyllum (Michx.) Nutt.—*B.* 21 / C.Hs / D.16.
**Chelidonium majus* L.—*B.* 2 / C.Hs / D.16.

52. *Fumariaceae*

- A.* Genera: 3. Species: 5. *B.* 21/2, 2/3. *C.* H/3, G/2. *D.* 15/1, 16/2, 17/2.
Dicentra canadensis (Goldie) Walp.—*B.* 21 / C.G / D.17.
 Perennating organ is intermediate between bulb and rhizome.
D. Cucullaria (L.) Bernh.—*B.* 21 / C.G / D.17.
 Perennating organ is intermediate between bulb and rhizome. See Pl. 4, Fig. 34.
Adlumia fungosa (Ait.) Greene—*B.* 2 / C.Hs / D.15.
Corydalis sempervirens (L.) Pers.—*B.* 2 / C.Hs / D.16.
C. flavula (Raf.) DC.—*B.* 2 / C.Hs / D.16.

53. *Cruciferae*

- A.* Genera: 24. Species: 57. *B.* 21/18, 2/22(+3), 1/17(+11). *C.* H/31, G/7, HH/2, Th/17. *D.* 16/31, 17/7, 19/2, 18/17.
**Lepidium campestre* (L.) Br.—*B.* 2 / C.Hs / D.16.
**L. Draba* L.—*B.* 21 / C.Hs / D.16.
L. virginicum L.—*B.* 2, 1 / D.Hs / D.16.
**L. densiflorum* Schrad.—*B.* 2, 1 / C.Hs / D.16.
**Thlaspi arvense* L.—*B.* 1 / C.Th / D.18.
**T. perfoliatum* L.—*B.* 1 / C.Th / D.18.
**Sisymbrium officinale* (L.) Scop.—*B.* 1 / C.Th / D.18.
**S. altissimum* L.—*B.* 2 / C.Hs / D.16.
**Sisymbrium Thalianum* (L.) J. Gay—*B.* 1 / C.Th / D.18.
Caŕŕile edulenta var. *lacustris* Fern.—*B.* 1 / C.Th / D.18.
**Brassica campestris* L.—*B.* 2, 1 / C.Hs / D.16.
**B. juncea* (L.) Cosson—*B.* 1 / C.Th / D.18.
**B. nigra* (L.) Koch—*B.* 1 / C.Th / D.18.
**B. arvensis* (L.) Rabenh.—*B.* 1 / C.Th / D.18.
**Raphanus Raphanistrum* L.—*B.* 2, 1 / C.Hs / D.16.
**Barbarea vulgaris* R.Br.—*B.* 21 / C.Hs / D.16.
**B. verna* (Mill.) Asch.—*B.* 21, 2 / C.Hs / D.16.

- Iodanthus pinnatifidus* (Michx.) Steud.—B. 2f / C.Hs / D.16.
Rorippa sessiliflora (Nutt.) Hitchc.—B. ②, ① / C.Hs / D.16.
R. palustris var. *glabrata* (Lunell) Victorin—B. ②, ① / C.Hs / D.16.
 var. *hispida* (Desv.) Rydb.
 **R. sylvestris* (L.) Besser—B. 2f / C.Hs / D.16.
 **Nasturtium officinale* R.Br.—B. 2f / C.HH / D.19.
 **Armoracia rusticana* Gaertn.—B. 2f / C.Grt / D.17.
A. aquatica (Eaton) Wieg.—B. 2f / C.HH / D.19.
Cardamine bulbosa (Schreb.) BSP.—B. 2f / C.Gst / D.17.
C. Douglasii (Torr.) Britt.—B. 2f / C.Gst / D.17.
C. pratensis var. *palustris* Wimm. & Gräb.—B. 2f / C.Hs / D.16.
C. pennsylvanica Muhl.—B. ①, ② / C.Hs / D.16.
C. parviflora var. *arenicola* (Britt.) O.E.Schultz—B. ①, ② / C.Hs / D.16.
Dentaria laciniata Muhl.—B. 2f / C.Gst / D.17.—(Pl. 4, Fig. 33).
D. multifida Muhl.—B. 2f / C.Grh / D.17.
D. diphylla Michx.—B. 2f / C.Grh / D.17.—(Pl. 5, Fig. 42).
D. heterophylla Nutt.—B. 2f / C.Gst / D.17.
Leavenworthia uniflora (Michx.) Britt.—B. ① / C.Th / D.18.
 **Capsella Bursa-pastoris* (L.) Medic.—B. ① / C.Th / D.18.
 **Camolina microcarpa* Andr.—B. ① / C.Th / D.18.
Draba brachycarpa Nutt.—B. ① / C.Th / D.18.
 **D. verna* L.—B. ① / C.Th / D.18.
D. caroliniana Walt.—B. ① / C.Th / D.18.
Descurainia brachycarpon (Richardson) Schulz—B. ②, ① / C.Hs / D.16.
Arabis virginica (L.) Poir.—B. ② / C.Hs / D.16.
A. pycnocarpa Hopkins—B. ② / C.Hs / D.16.
A. patens Sulliv.—B. ② / C.Hs / D.16.
A. dentata T.&G.—B. 2f / C.Hs / D.16.
A. viridis var. *Deamii* Hopkins—B. ② / C.Hs / D.16.
A. laevigata (Muhl.) Poir.—B. ② / C.Hs / D.16.
A. glabra (L.) Bernh.—B. ② / C.Hs / D.16.
A. Drummondii A.Gray—B. ② / C.Hs / D.16.
A. lyrata L.—B. 2f, ② / C.Hs / D.16.
A. canadensis L.—B. ② / C.Hs / D.16.
Erysimum asperum DC.—B. ② / C.Hs / D.16.
 **E. repandum* L.—B. ① / C.Th / D.18.
E. cheiranthoides L.—B. ② / C.Hs / D.16.
 **Alyssum alyssoides* L.—B. ① / C.Th / D.18.
 **Berteroa incana* (L.) DC.—B. ②, ① / C.Hs / D.16.
 **Hesperis matronalis* L.—B. ②, 2f / C.Hs / D.16.
 **Conringia orientalis* (L.) Dumort.—B. ① / C.Th / D.18.

55. *Capparidaceae*

- A. Genera: 1. Species: 2. B. ①/2. C. Th/2. D. 18/2.*
Polanisia graveolens Raf.—B. ① / C.Th / D.18.
P. trachysperma T.&G.—B. ① / C. Th / D.18.

55. *Sarraceniaceae*

A. Genera: 1. Species: 1. *B.* 2f / 1. *C.* H / 1. *D.* 14 / 1.
Sarracenia purpurea L.—*B.* 2f / *C.Hr* / *D.* 14.

56. *Droseraceae*

A. Genera: 1. Species: 2. *B.* ② / (2), 2f / 2. *C.* H / 2. *D.* 14 / 2.
Drosera rotundifolia L.—*B.* 2f, ② / *C.Hr* / *D.* 14.
D. intermedia Hayne—*B.* 2f, ② / *C.Hr* / *D.* 14.

57. *Podostemaceae*

A. Genera: 1. Species: 1. *B.* 2f / 1. *C.* HH / 1. *D.* 19 / 1.
Podostemon ceratophyllum Michx.—*B.* 2f / *C.HH* / *D.* 19.

58. *Crassulaceae*

A. Genera: 2. Species: 4. *B.* 2f / 4. *C.* Ch / 2, H / 2. *D.* 12 / 2, 16 / 2.
 **Sedum acre* L.—*B.* 2f / *C.Ch* / *D.* 12.
S. telephioides Michx.—*B.* 2f / *C.Hp* / *D.* 16.
S. ternatum Michx.—*B.* 2f / *C.Ch* / *D.* 12.
Penthorum sedoides L.—*B.* 2f / *C.Hpr* / *D.* 16.

59. *Saxifragaceae*

A. Genera: 7. Species: 12. *B.* ½ / 1, 2f / 11. *C.* N / 1, H / 11. *D.* 4 / 1, 14 / 8, 16 / 3.
Sullivantia ohionis T.&G.—*B.* 2f / *C.Hr* / *D.* 14.
Saxifraga virginensis Michx.—*B.* 2f / *C.Hrr* / *D.* 14.
S. pennsylvanica L.—*B.* 2f / *C.Hrr* / *D.* 14.
Mitella diphylla L.—*B.* 2f / *C.Hsr* / *D.* 16.
Heuchera villosa var. *macrorrhiza* (Small) Rosendahl, Butters & Lakela—*B.* 2f / *C.Hr* / *D.* 14.
H. parviflora var. *Rugelii* (Shuttlew. apud Kunze) Rosendahl, Butters & Lakela—*B.* 2f / *C.Hr* / *D.* 14.
 var. *interior* Rosendahl, Butters & Lakela
H. americana L. var. *brevipetala* Rosendahl, Butters & Lakela—*B.* 2f / *C.Hr* / *D.* 14
 var. *hirsuticaulis* Rosendahl, Butters & Lakela
H. Richardsonii R.Br. var. *Grayana* Rosendahl, Butters & Lakela—*B.* 2f / *C.Hr* / *D.* 14.
 var. *affinis* Rosendahl, Butters & Lakela
Chrysoplenium americanum Schwein.—*B.* 2f / *C.Hpr* / *D.* 16.
Parnassia americana Muhl.—*B.* 2f / *C.Hs* / *D.* 16.
Hydrangia arborescens L.—*B.* ½ / *C.N* / *D.* 4.
 var. *sterilis* T.&G.—var. *Deamii* St. John

60. *Grossulariaceae*

A. Genera: 2. Species: 4. *B.* ½ / 4. *C.* N / 4. *D.* 4 / 3, 5 / 1, 7 / 2.
Ribes americanum Mill.—*B.* ½ / *C.N* / *D.* 4.
Grossularia cynosbati (L.) Mill.—*B.* ½ / *C.N* / *D.* 5, 7.
G. missouriensis (Nutt.) Gov. & Britt.—*B.* ½ / *C.N* / *D.* 4, 7.
G. hirtella (Michx.) Spach—*B.* ½ / *C.N* / *D.* 4.

61. *Altingiaceae*

A. Genera: 1. Species: 1. *B.* ½ / 1. *C.* MM / 1. *D.* 2 / 1.
Liquidambar styraciflua L.—*B.* ½ / *C.MM* / *D.* 2.

62. *Hamamelidaceae*

A. Genera: 1. Species: 1. B. $\frac{1}{2}$ / 1. C. M / 1. D. 4 / 1.

Hamamelis virginiana L.—B. $\frac{1}{2}$ / C.M / D.4.

63. *Platanaceae*

A. Genera: 1. Species: 1. B. $\frac{1}{2}$ / 1. C. MM / 1. D. 2 / 1.

Platanus occidentalis L.—B. $\frac{1}{2}$ / C.MM / D.2.

64. *Rosaceae*

A. Genera: 20. Species: 100. B. $\frac{1}{2}$ / 29, $\frac{1}{2}$ / 45, $\frac{21}{25}$, ② / 1, ① / (1). C. MM / 6, M / 36, N / 16, H / 41, HH / 1. D. 2 / 29, 4 / 34, 5 / 11, 7 / 50, 14 / 4, 16 / 22.

Physocarpus opulifolius (L.) Maxim.—B. $\frac{1}{2}$ / C.N / D.5.

var. *intermedium* (Rydb.) Fern.

Spiraea alba DuRoi.—B. $\frac{1}{2}$ / C.N / D.4.

S. tomentosa L.—B. $\frac{1}{2}$ / C.N / D.4.

Aruncus allegheniensis var. *pubescens* (Rydb.) Fern.—B. $\frac{21}{2}$ / C.Hp / D.16.

Gillenia stipulata (Muhl.) Trel.—B. $\frac{21}{2}$ / C.Hp / D.16.

Malus coronaria (L.) Mill.—B. $\frac{1}{2}$ / C.M / D.2.

var. *dasycalyx* Rehder

M. ioensis (Wood.) Britt.—B. $\frac{1}{2}$ / C.M / D.2.

Sorbus decora (Sarg.) Schneid.—B. $\frac{1}{2}$ / C.M / D.4.

Aronia melanocarpa (Michx.) Ell.—B. $\frac{1}{2}$ / C.N / D.4.

A. floribunda (Michx.) Ell.—B. $\frac{1}{2}$ / C.N / D.4.

A. humilis Wieg.—B. $\frac{1}{2}$ / C.N / D.4.

A. canadensis (L.) Medic.—B. $\frac{1}{2}$ / C.M / D.2.

A. laevis Wieg.—B. $\frac{1}{2}$ / C.MM / D.2.

Crataegus crus-galli L.—B. $\frac{1}{2}$ / C.M / D. 2, 7.

var. *pyracanthifolia* Ait.

C. pyracanthoides var. *arborea* (Beadle) Palmer—B. $\frac{1}{2}$ / C.M / D.2.

C. regalis Beadle—B. $\frac{1}{2}$ / C.M. / D. 2, 7.

C. acutifolia Sarg.—B. $\frac{1}{2}$ / C.M / D. 2, 7.

C. punctata Jacq.—B. $\frac{1}{2}$ / C.M / D. 2, 7.

var. *aurea* Ait.—var. *canescens* Britt.

C. collina Chapm.—B. $\frac{1}{2}$ / C.M / D. 2, 7.

C. grandis Ashe—B. $\frac{1}{2}$ / C.M / D. 2, 7.

C. disperma Ashe—B. $\frac{1}{2}$ / C.M / D. 2, 7.

C. viridis L.—B. $\frac{1}{2}$ / D.M. / D. 2, 7.

C. Margaretta Ashe—B. $\frac{1}{2}$ / C.M / D. 2, 7.

var. *angustifolia* Palmer—var. *xanthocarpa* Sarg.

C. intricata Lange—B. $\frac{1}{2}$ / C.M / D. 4, 7.

C. rubella Beadle—B. $\frac{1}{2}$ / C.M / D. 4, 7.

C. biltmoreana Beadle—B. $\frac{1}{2}$ / C.M / D. 4, 7.

C. macrosperma Ashe—B. $\frac{1}{2}$ / C.M / D. 4, 7.

C. pruinosa (Wendl.) K.Koch—B. $\frac{1}{2}$ / C.M / D. 4, 7.

C. Gatlingeri Ashe—B. $\frac{1}{2}$ / C.M / D. 4, 7.

C. platycarpa Sarg.—B. $\frac{1}{2}$ / C.M / D. 2, 7.

C. rugosa Ashe—B. $\frac{1}{2}$ / C.M / D. 4, 7.

C. prona Ashe—B. $\frac{1}{2}$ / C.M / D. 2, 7.

- C. pedicillata* Sarg.—B. 1 / C.M / D. 2, 7.
 var. *albicans* (Ashe) Palmer
C. Putnamiana Sarg.—B. 1 / C.M / D. 4, 7.
C. mollis (T.&G.) Scheele—B. 1 / C.MM / D. 2, 7
 f. *dumetosa* (Sarg.) Palmer
C. Kelloggii Sarg.—B. 1 / C.M / D. 2, 7.
C. Phaenopyrum (L.f.) Medic.—B. 1 / C.M / D. 2, 7.
C. Calpodendron (Ehrh.) Medic.—B. 1 / C.M / D. 4, 7.
C. succulenta Schrader—B. 1 / C.M / D. 2, 7.
C. incaedua Sarg.—B. 1 / C.M / D. 2, 7.
Rubus odoratus L.—B. 1 / C.Hp / D.4.
R. pubescens Raf.—B. 2f / C.Hpr / D. 7, 16.
R. occidentalis L.—B. 1 / C.Hpr / D. 5, 7.
 f. *pallidus* (Bailey) Robinson
R. idaeus var. *canadensis* Richardson—B. 1 / C.Hp / D. 4, 7.
 var. *strigosus* (Michx.) Maxim.
R. hispidus L.—B. 1 / C.Hpr / D. 5, 7.
 f. *pleniflorus* Nieuwl.
R. flagellaris Willd.—B. 1 / C.Hpr / D. 5, 7.
R. Enslenii Tratt.—B. 1 / C.Hpr / D. 5, 7.
R. centralis Bailey—B. 1 / C.Hpr / D. 5, 7.
R. Deamii Bailey—B. 1 / C.Hpr / D. 5, 7.
R. allegheniensis Porter—B. 1 / C.Hp / D. 4, 7.
R. impos Bailey—B. 1 / C.Hp / D. 4, 7.
R. laudatus Berger—B. 1 / C.Hp / D. 4, 7.
R. argutus Link—B. 1 / C.Hp / D. 4, 7.
R. ostryfolius Rydb.—B. 1 / C.Hp / D. 4, 7.
R. impar Bailey—B. 1 / C.Hp / D. 4, 7.
R. frondosus Bigel.—B. 1 / C.Hp / D. 5, 7.
R. abactus Bailey—B. 1 / C.Hpr / D. 5, 7.
Fragaria virginiana Duchesne—B. 2f / C.Hrr / D.14.
 var. *illinoensis* (Prince) Gray
F. vesca L.—B. 2f / C.Hrr / D.14.
**Duchesnea indica* (Andr.) Focke—B. 2f / C.Hsr / D.16.
Potentilla simplex Michx. var. *typica* Fern.—B. 2f / C.Hsr / D.16.
 var. *argyrisma* Fern.
P. fruticosa L.—B. 1 / C.N / D.4.
P. arguta Pursh—B. 2f / C.Hs / D.16.
P. Anserina L.—B. 2f / C.Hrr / D.14.
P. palustris (L.) Scop.—B. 2f / C.HH / D.16.
**P. recta* L.—B. 2f / C.Hs / D.16.
P. monspeliensis L.—B. ②, ① / C.Hs / D.16
P. argentea L.—B. 2f / C.Hsr / D.16.
Waldsteinia fragarioides (Michx.) Tratt.—B. 2f / C.Hrr / D.14
Geum vernal (Raf.) T.&G.—B. 2f / C.Hs / D.16.
G. rivale L.—B. 2f / C.Hs / D.16.
G. canadense Jacq.—B. 2f / C.Hs / D.16.
G. virginianum L.—B. 2f / C.Hs / D.16.

G. aleppicum var. *strictum* (Ait.) Fern.—B. 2f / C.Hs / D.16.

G. laciniatum Murr.—B. 2f / C.Hs / D.16.

var. *trichocarpum* Fern.

Filipendula rubra (Hill) Rob.—B. 2f / C.Hp / D.16.

Agrimonia gryposepala Wallr.—B. 2f / C.Hpr / D.16.

A. rostellata Wallr.—B. 2f / C.Hpr / D.16.

A. parviflora Ait.—B. 2f / C.Hpr / D.16.

A. pubescens Wallr.—B. 2f / C.Hp / D.16.

Sanguisorba canadensis L.—B. 2f / C.Hs / D.16.

Rosa setigera Michx.—B. 7 / C.M / D. 5, 7.

var. *tomentosa* T.&G.

**R. rubiginosa* L.—B. 7 / C.N / D. 5, 7.

**R. micrantha* Borrer.—B. 7 / C.N / D. 4, 7.

R. palustris Marsh.—B. 7 / C.N / D. 4, 7.

R. carolina L.—B. 7 / C.N / D. 4, 7.

var. *glandulosa* (Crep.) Farw.—var. *subulosa* Erlanson

var. *Lyoni* (Pursh) Palmer & Steyermark

(Certain species of this complex will be treated as varieties in Deam's "Flora" and are here omitted.)

R. blanda Ait.—B. 7 / C.N / D. 4, 7.

var. *carpohispida* Schuette—var. *glandulosa* Schuette—var. *hispida* Farw.

R. subblanda Rydb.—B. 7 / C.N / D.4.

R. suffulta Greene.—B. 7 / C.N / D. 4, 7.

R. rudiuscula Greene.—B. 7 / C.N / D. 4, 7.

Prunus americana Marsh.—B. 7 / C.M / D.2.

P. lanata (Sudw.) Mack.&Bush.—B. 7 / C.M / D.2.

P. pumila L.—B. 7 / C.N / D.4.

P. angustifolia Marsh.—B. 7 / C.M / D.4.

P. nigra Ait.—B. 7 / C.M / D.2.

P. hortulana Bailey.—B. 7 / C.M / D.2.

P. pennsylvanica L.f.—B. 7 / C.MM / D.2.

P. virginiana L.—B. 7 / C.M / D.4.

P. serotina Ehrh.—B. 7 / C.MM / D.2.

**P. Mahaleb* L.—B. 7 / C.M / D.2.

65. Leguminosae

A. Genera: 31. Species: 89. B. 7/7, 7/3, 2f/60, ②/4, ①/15(+2). C. MM/5, M/5, Ch/1, H/59, G/4, Th/15. D. 2/7, 4/2, 5/1, 7/4, 12/1, 14/4, 15/6, 16/50, 17/4, 18/15.

**Desmanthus illinoensis* (Michx.) Macm.—B. 2f / C.Hp / D.16.

Cercis canadensis L.—B. 7 / C.M / D.2.

Cassia nictitans L.—B. ① / C.Th / D.18.

var. *leiocarpa* Fern.

C. fasciculata Michx.—B. ① / C.Th / D.18.

var. *robusta* (Pollard) Macbride

**C. occidentalis* L.—B. ① / C.Th / D.18.

C. marilandica L.—B. 2f / C.Hp / D.16.

- C. Medsgeri* Shafer.—B. 2f / C.Hp / D.16.
Gleditsia aquatica Marsh.—B. h / C.M / D. 2, 7.
G. tricanthos L.—B. h / C.MM / D. 2, 7.
 f. *inermis* Pursh
G. texana Sarg.—B. h / C.MM / D. 2, 7.
Gymnocladus dioica (L.) Koch.—B. h / C.MM / D.2.
Cladrastis lutea (Michx.f.) Koch.—B. h / C.MM / D.2.
Baptisia leucophaea Nutt.—B. 2f / C.Hp / D.16.
B. australis (L.) R.Br.—B. 2f / C.Hp / D.16.
B. tinctoria (L.) R.Br.—B. 2f / C.Hp / D.16.—(Pl. 4, Fig. 32).
B. leucantha T.&G.—B. 2f / C.Hp / D.16.
**Crotalaria sagittalis* L.—B. ① / C.Th / D.18.
Lupinus perennis L.—B. 2f / C.Hs / D.16.
**Medicago sativa* L.—B. 2f / C.Hp / D.16.
**M. lupulina* L.—B. ① / C.Th / D.18.
**Melilotus alba* Desv.—B. ② / C.Hs / D.16.
**M. officinalis* (L.) Lam.—B. ② / C.Hs / D.16.
**Trifolium arvense* L.—B. ① / C.Th / D.18.
**T. pratense* L.—B. 2f / C.Hr / D.14.
**T. resupinatum* L.—B. ① / C.Th / D.18.
**T. repens* L.—B. 2f / C.Hsr / D.14.
**T. hybridum* L.—B. 2f / C.Hr / D.14.
T. reflexum var. *glabrum* Loj.—B. ②, ① / C.Hr / D.14.
**T. procumbens* L.—B. ① / C.Th / D.18.
**T. agrarium* L.—B. ① / C.Th / D.18.
Psoralea tenuiflora Pursh.—B. 2f / C.Hp / D.16.
P. stipulata T.&G.—B. 2f / C.Hp / D.16.
P. Onobrychis Nutt.—B. 2f / C.Hpr / D.16.
P. psoraloides (Walt.) Cory.—B. 2f / C.Hp / D.16.
Amorpha canescens Nutt.—B. h / C.M / D.4.
A. fruticosa L.—B. h / C.M / D.4.
 var. *emarginata* Pursh.—var. *angustifolia* Pursh
Dalea alopecuroides Willd.—B. ① / C.Th / D.18.
Petalostemum purpureum (Vent.) Rydb.—B. 2f / C.Hp / D.16.
P. candidum (Willd.) Michx.—B. 2f / C.Hp / D.16.
Tephrosia virginiana (L.) Pers.—B. 2f / C.Hp / D.16.
 var. *holosericea* (Nutt.) T. & G.
Wisteria macrostachya Nutt.—B. h / C.M / D.5.
Robinia Pseudo-Acacia L.—B. h / C.MM / D. 2, 7.
Astragalus canadensis L.—B. 2f / C.Hp / D.16.
 var. *longilobus* Fassett
**Coronilla varia* L.—B. 2f / C.Gr / D.17.
Stylosanthes biflora (L.) BSP.—B. 2f / C.Hp / D.16.
 var. *hispidissima* (Michx.) Pollard & Ball
Desmodium rotundifolium (Michx.) DC.—B. 2f / C.Hp / D.16.
D. sessilifolium (Torr.) T.&G.—B. 2f / C.Hp / D.16.
D. nudiflorum (L.) DC.—B. 2f / C.Hp / D.16.
D. pauciflorum (Nutt.) DC.—B. 2f / C.Hp / D.16.

- D. acuminatum* (Michx.) DC.—B. 2f / C.Hp / D.16.
D. bracteosum (Michx.) DC.—B. 2f / C.Hp / D.16.
D. canescens (L.) DC.—B. 2f / C.Hp / D.16.
D. illinoensis Gray—B. 2f / C.Hp / D.16.
D. laevigatum (Nutt.) DC.—B. 2f / C.Hp / D.16.
D. viridiflorum (L.) Beck—B. 2f / C.Hp / D.16.
D. Dillenii Darl.—B. 2f / C.Hp / D.16.
D. canadense (L.) DC.—B. 2f / C.Hp / D.16.
D. paniculatum (L.) DC.—B. 2f / C.Hp / D.16.
 var. *pubens* T.&G.
D. marilandicum (L.) DC.—B. 2f / C.Hp / D.16.
D. ciliare DC.—B. 2f / C.Hp / D.16.
D. rigidum (Ell.) DC.—B. 2f / C.Hp / D.16.
**Lespedeza striata* (Thunb.) H.&A.—B. ① / C.Th / D.18.
**L. stipulacea* Maxim.—B. ① / C.Th / D.18.
L. capitata Michx.—B. 2f / C.Hp / D.16.
 var. *velutina* (Bickn.) Fern.—var. *longifolia* (DC.) T.&G.
L. Nuttallii Dar.—B. 2f / C.Hp / D.16.
L. hirta (L.) Hornem.—B. 2f / C.Hp / D.16.
L. virginica (L.) Britt.—B. 2f / C.Hp / D.16.
 f. *Deamii* Hopkins
L. intermedia (Wats.) Britt.—B. 2f / C.Hp / D.16.
 f. *Hahnii* (Blake) Hopkins
L. repens (L.) Bart.—B. 2f / C.Hp / D.16.
L. violacea (L.) Pers.—B. 2f / C.Hp / D.16.
L. Stuevei Nutt.—B. 2f / C.Hp / D.16.
 f. *angustifolia* (Britt.) Hopkins
L. procumbens Michx.—B. 2f / C.Hp / D.16.
 var. *elliptica* Blake
**Vicia villosa* Roth.—B. ②, ① / C.Hp / D.16.
V. caroliniana Walt.—B. 2f / C.Hp / D.16.
V. americana Muhl.—B. 2f / C.Hp / D.16.
Lathyrus ochroleucus Hook.—B. 2f / C.Hp / D.15.
L. japonicus var. *glaber* (Ser.) Fern.—B. 2f / C.Gr / D.17.
L. venosus Muhl.—B. 2f / C.Hp / D.15.
 var. *intonsus* Butters & St. John
L. palustris L.—B. 2f / C.Hp / D.15.
 var. *myrtifolius* (Muhl.) Gray.
Clitoria mariana L.—B. 2f / C.Hp / D.15.
Amphicarpa bracteata (L.) G.Don.—B. 2f / C.Hpr / D.16.
A. comosa (L.) G.Don.—B. 2f / C.Hpr / D.16.
Apios americana Medic.—B. 2f / C.Gst / D.17.
Galactia volubilis var. *mississippiensis* Vail—B. 2f / C.Hp / D.15.—(Pl. 1, Fig. 9).
Phaesolus polystachys (L.) BSP.—B. 2f / C.Ch / D.12.
Strophostyles helvola (L.) Britt.—B. ① / C.Th / D.18.
S. umbellata (Muhl.) Britt.—B. 2f / C.Gr / D.17.
S. leiosperma (T.&G.) Piper—B. ① / C.Th / D.18.

66. *Geraniaceae*

A. Genera: 1. Species: 6. B. 2f / 1, ② / 1, ① / 4 (+1). C. H/2, Th/4. D. 16/2, 18/4.

Geranium maculatum L.—B. 2f / C.Hsr / D.16.

G. Robertianum L.—B. ①, ② / C.Hs / D.16.

**G. columbinum* L.—B. ① / C.Th / D.18.

G. carolinianum L.—B. ① / C.Th / D.18.

var. *confertiflorum* Fern.

G. Bicknellii Britt.—B. ① / C.Th / D.18.

**B. pusillum* Burm.—B. ① / C.Th. D.18.

67. *Oxalidaceae*

A. Genera: 1. Species: 6. B. 2f / 4, ② / 1. C. H/5, G/1. D. 16/5, 17/1.

Oxalis violacea L.—B. 2f / C.Gb / D.17.—(Pl. 4, Fig. 36.)

O. grandis Small—B. 2f / C.Hpr / D.16.

O. repens Thunb.—B. ② / C.Hpr / D.16.

O. stricta L.—B. 2f / C.Hp / D.16.

var. *pileocarpa* Wieg.

O. florida Salisb.—B. 2f / C.Hp / D.16.

O. europaea Jordan—B. 2f / C.Hpr / D.16.

f. *cymosa* (Small) Wieg.—f. *villicaulis* Wieg.

var. *Bushii* f. *subglabrata* Wieg.—f. *vestita* Wieg.

68. *Linaceae*

A. Genera: 1. Species: 5. B. 2f / 4, ① / 1. C. H/4, Th/1. D. 16/4, 18/1.

Linum sulcatum Riddell—B. ① / C.Th / D.18.

L. floridanum var. *intercursum* (Bickn.) Weatherby—B. 2f / C.Hp / D.16.

L. virginianum L.—B. 2f / C.Hp / D.16.

L. striatum Walt.—B. 2f / C.Hp / D.16.

L. medium (Planch.) Britt.—B. 2f / C.Hp / D.16.

69. *Rutaceae*

A. Genera: 2. Species: 2. B. 1 / 2. C. M/2. D. 4/2, 7/1.

Zanthoxylum americanum Mill.—B. 1 / C.M / D. 4, 7.

Ptelea trifoliata L.—B. 1 / C.M / D.4.

var. *Deamiana* Nieuwl.

70. *Simarubaceae*

A. Genera: 1. Species: 1. B. 1 / 1. C. MM/1. D. 2/1.

**Ailanthus altissima* (Mill.) Swingle—B. 1 / C.MM / D.2.

71. *Polygalaceae*

A. Genera: 1. Species: 8. B. 2f / 3, ① / 5. C. H/3, Th/5. D. 16/3, 18/5.

Polygala paucifolia Willd.—B. 2f / C.Hpr / D.16.

P. polygama Walt.—B. 2f / C.Hp / D.16.—(Pl. 6, Fig. 3).

P. Senega L.—B. 2f / C.Hp / D.16.

P. verticillata L.—B. ① / C.Th / D.18.

var. *sphenostachya* Pennell

P. Pretzii Pennell.—B.① / C.Th / D.18.

P. ambigua Nutt.—B.① / C.Th / D.18.

P. cruciata L.—B.① / C.Th / D.18.

P. sanguinea L.—B.① / C.Th / D.18.

72. Euphorbiaceae

A. Genera: 6. Species: 25. B. 2f/4, ②/2, ①/19(+2). C. H/5, G/1, Th/19.
D. 16/5, 17/1, 18/19.

Phyllanthus carolinensis Walt.—B.① / C.Th / D.18.

Croton glandulosus var. *septentrionalis* Muell.—B.① / C.Th / D.18.

C. capitatus Michx.—B.① / C.Th / D.18.

C. monanthogynus Michx.—B.① / C.Th / D.18.

Crotonopsis elliptica Willd.—B.① / C.Th / D.18.

Acalypha ostryaefolia Riddell.—B.① / C.Th / D.18.

A. rhomboidea Raf.—B.① / C.Th / D.18.

var. *Deamii* Weatherby

A. virginica L.—B.① / C.Th / D.18.

A. gracilis Gray.—B.① / C.Th / D.18.

Tragia cordata Michx.—B.2f / C.Hp / D.16.

Euphorbia marginata Pursh.—B.① / C.Th / D.18.

E. polygonifolia L.—B.① / C.Th / D.18.

E. serpens HBK.—B.① / C.Th / D.18.

E. maculata L.—B.① / C.Th / D.18.

E. humistrata Engelm.—B.① / C.Th / D.18.

E. hirsuta (Torr.) Wieg.—B.① / C.Th / D.18.

E. nutans Lag.—B.① / C.Th / D.18.

E. corollata L.—B.2f / C.Grt / D.17.

E. dentata Michx.—B.① / C.Th / D.18.

E. heterophylla L.—B.②, ① / C.Hp / D.16.

E. obtusata Pursh.—B.① / C.Th / D.18.

**E. virgata* Waldst. & Kit.—B.2f / C.Hp / D.16.

**E. Cyparissias* L.—B.2f / C.Hpr / D.16.

**E. Peplus* L.—B.① / C.Th / D.18.

E. commutata Engelm.—B.②, ① / C.Hpr / D.16.

73. Callitrichaceae

A. Genera: 1. Species: 2. B. 2f/1, ①/1. C. HH/1, Th/1. D. 18/1, 19/1.

Callitriche Austini Engelm.—B.① / C.Th / D.18.

C. heterophylla Pursh.—B.2f / C.HH / D.19.

74. Limnanthaceae

A. Genera: 1. Species: 1. B. ①/1. C. Th/1. D. 18/1.

Floerkea proserpinacoides Willd.—B.① / C.Th / D.18.

75. Anacardiaceae

A. Genera: 1. Species: 8. B. 2f/8. C. MM/1, M/6, N/1(+1). D. 4/8, 5/1.

Rhus copallina L.—B.2f / C.M / D.4.

- R. typhina* L.—B. $\frac{1}{2}$ / C.M / D.4.
R. glabra L.—B. $\frac{1}{2}$ / C.M / D.4.
 var. *borealis* Britt.
R. pulvinata Greene—B. $\frac{1}{2}$ / C.M. / D.4.
R. Vernix L.—B. $\frac{1}{2}$ / C.M / D.4.
R. Toxicodendron L.—B. $\frac{1}{2}$ / C.MM (N) / D.5 (4).
R. aromatica Ait.—B. $\frac{1}{2}$ / C.N / D.4.
R. trilobata var. *arenaria* (Greene) Barkley—B. $\frac{1}{2}$ / C.M D.4.

76. *Aquifoliaceae*

- A.* Genera: 2. Species: 3. *B.* $\frac{1}{2}$ / 3. *C.* M / 3. *D.* 4 / 3.
Ilex decidua Walt.—B. $\frac{1}{2}$ / C.M / D.4.
I. verticillata (L.) Gray—B. $\frac{1}{2}$ / C.M / D.4.
Nemopanthes mucronata (L.) Trel.—B. $\frac{1}{2}$ / C.M / D.4.

77. *Celastraceae*

- A.* Genera: 2. Species: 4. *B.* $\frac{1}{2}$ / 4. *C.* MM / 1, N / 2. *D.* 4 / 2, 5 / 2
Evonymus atropurpureus Jacq.—B. $\frac{1}{2}$ / C.M / D.4.
E. americanus L.—B. $\frac{1}{2}$ / C.N / D.4.
E. obovatus Nutt.—B. $\frac{1}{2}$ / C.N / D.5.
Celastrus scandens L.—B. $\frac{1}{2}$ / C.MM / D.5.

78. *Staphyleaceae*

- A.* Genera: 1. Species: 1. *B.* $\frac{1}{2}$ / 1. *C.* M / 1. *D.* 4 / 1.
Staphylea trifolia L.—B. $\frac{1}{2}$ / C.M / D.4.

79. *Aceraceae*

- A.* Genera: 1. Species: 5. *B.* $\frac{1}{5}$ / 5. *C.* MM / 5. *D.* 2 / 5.
Acer negundo L.—B. $\frac{1}{5}$ / C.MM / D.2.
 var. *violaceum* Kirchner
A. saccharinum L.—B. $\frac{1}{5}$ / C.MM / D.2.
A. rubrum L.—B. $\frac{1}{5}$ / C.MM / D.2.
 var. *Drummondii* (Hook. & Arn.) T.&G.
A. nigrum Michx.f.—B. $\frac{1}{5}$ / C.MM / D.2.
 f. *pubescens*
A. saccharum Marsh.—B. $\frac{1}{5}$ / C.MM / D.2.
 var. *Rugelii* (Pax) Rehder—var. *Schneckii* Rehder

80. *Hippocastanaceae*

- A.* Genera: 1. Species: 3. *B.* $\frac{1}{3}$ / 3. *C.* MM / 3. *D.* 2 / 3.
**Aesculus Hippocastanum* L.—B. $\frac{1}{3}$ / C.MM / D.2.
A. glabra Willd.—B. $\frac{1}{3}$ / C.MM / D.2.
A. octandra Marsh.—B. $\frac{1}{3}$ / C.MM / D.2.

81. *Sapindaceae*

- A.* Genera: 1. Species: 1. *B.* $\frac{1}{1}$ / 1. *C.* M / 1. *D.* 2 / 1.
**Koelreuteria paniculata* Laxm.—B. $\frac{1}{1}$ / C.M / D.2.

82. *Balsaminaceae*

- A.* Genera: 1. Species: 2. *B.* ① / 2. *C.* Th / 2. *D.* 18 / 2

Impatiens biflora Walt.—B.① / C.Th / D.18.

I. pallida Nutt.—B.① / C.Th / D.18.

83. *Rhamnaceae*

A. Genera: 2. Species: 6. B. ½ / 6. C. M/3, N/3. D. 4/6.

Rhamnus caroliniana Walt.—B. ½ / C.M / D.4.

f. *mollis* (Fern.) Deam

R. lanceolata Pursh.—B. ½ / C.M / D.4.

R. alnifolia L'Her.—B. ½ / C.N / D.4.

**R. Frangula* L.—B. ½ / C.M / D.4.

Ceanothus americanus L.—B. ½ / C.N / D.4.

C. ovalis Desf.—B. ½ / C.N / D.4.

84. *Vitaceae*

A. Genera: 3. Species: 9. B. ½ / 9. C. MM/9. D. 5/9.

Vitis labrusca L.—B. ½ / C.MM / D.5.

V. aestivalis Michx.—B. ½ / C.MM / D.5.

V. cinerea Engelm.—B. ½ / C.MM / D.5.

V. cordifolia Michx.—B. ½ / C.MM / D.5.

V. palmata Vahl.—B. ½ / C.MM / D.5.

V. vulpina L.—B. ½ / C.MM / D.5.

var. *syrticola* Fern. & Wieg.

Parthenocissus quinquefolia (L.) Planch.—B. ½ / C.MM / D.5.

var. *hirsuta* (Donn.) Planch.

P. vitaceae (Knerr) Hitchc.—B. ½ / C.MM / D.5.

Ampelopsis cordata Michx.—B. ½ / C.MM / D.5.

85. *Tiliaceae*

A. Genera: 1. Species: 2. B. ½ / 2. C. MM/2. D. 2/2.

Tilia glabra Vent.—B. ½ / C.MM / D.2.

T. heterophylla Vent.—B. ½ / C.MM / D.2.

86. *Malvaceae*

A. Genera: 6. Species: 13. B. 2½ / 7, ②/2, ①/4(+1). C. H/9, Th/4. D. 16/9, 18/4.

**Abutilon Theophrasti* Medic.—B.① / C.Th / D.18.

**Malva sylvestris* var. *mauretiana* (L.) Boiss.—B.② / C.Hs / D.16.

**M. rotundifolia* L.—B.① / C.Th / D.18.

**M. neglecta* Wallr.—B.②, ① / C.Hs / D.16.

**M. moschata* L.—B. 2½ / C.Hs / D.16.

Callirhoe triangulata (Leavenw.) A. Gray.—B. 2½ / C.Hs / D.16.

Napaea dioica L.—B. 2½ / C.Hs / D.16.

Sida spinosa L.—B.① / C.Th / D.18.

Hibiscus militaris Cav.—B. 2½ / C.Hp / D.16.

H. Moscheutos L.—B. 2½ / C.Hp / D.16.

H. palustris L.—B. 2½ / C.Hp / D.16.

H. lasiocarpus Cav.—B. 2½ / C.Hp / D.16.

**H. Trionum* L.—B.① / C.Th / D.18.

87. *Hypericaceae*

A. Genera: 2. Species: 20. B. $\frac{1}{2}$ / 4, $\frac{2}{4}$ / 14, ① / 4. C. N / 4, H / 14, Th / 2
D. 4 / 4, 16 / 14, 18 / 2.

Ascyrum hypericoides var. *multicaule* (Michx.) Fern.—B. $\frac{1}{2}$ / C.N / D.4.

Hypericum canadense L.—B. $\frac{2}{4}$, ① / C.Hp / D.16.

H. boreale (Britt.) Bickn.—B. $\frac{2}{4}$ / C.Hpr / D.16.

H. aureum Bartr.—B. $\frac{1}{2}$ / C.N / D.4.

H. Ascyron L.—B. $\frac{2}{4}$ / C.Hpr / D.16.

H. adpressum Bart.—B. $\frac{2}{4}$ / C.Hpr / D.16.

H. majus (Gray) Britt.—B. $\frac{2}{4}$, ① / C.Hp / D.16.

H. Kalmianum L.—B. $\frac{1}{2}$ / C.N / D.4.

H. Drummondii (Grev. & Hook.) T.&G.—B. ① / C.Th / D.18.

H. dolabriforme Vent.—B. $\frac{2}{4}$ / C.Hp / D.16.

H. cistifolium Lam.—B. $\frac{2}{4}$ / C.Hp / D.16.

H. gentianoides (L.) BSP.—B. ① / C.Th / D.18.

H. punctatum Lam.—B. $\frac{2}{4}$ / C.Hpr / D.16.

**H. perforatum* L.—B. $\frac{2}{4}$ / C.Hp / D.16.

H. prolificum L.—B. $\frac{1}{2}$ / C.N / D.4.

H. mutilum L.—B. $\frac{2}{4}$, ① / C.Hp / D.16.—(Pl. 5, Fig. 46).

H. denticulatum Walt.—B. $\frac{2}{4}$ / C.Hp / D.16.

H. virginicum L.—B. $\frac{2}{4}$ / C.Hpr / D.16.

var. *Fraseri* (Spach.) Fern.

H. petiolatum Walt.—B. $\frac{2}{4}$ / C.Hpr / D.16.

var. *tubulosum* (Walt.) Fern.

88. *Cistaceae*

A. Genera: 3. Species: 8. B. $\frac{1}{2}$ / 1, $\frac{2}{4}$ / 7. C. Ch / 3, H / 5(+2). D. 9 / 3,
16 / 5(+2).

Helianthemum canadense (L.) Michx.—B. $\frac{2}{4}$ / C.Ch (H) / D.9 (16).

H. Bicknellii Fern.—B. $\frac{2}{4}$ / C.Ch (H) / D.9 (16).

Hudsonia tomentosa var. *intermedia* Peck—B. $\frac{1}{2}$ / C.Ch / D.9.

Lechea mucronata Raf.—B. $\frac{2}{4}$ / C.Hp / D.16.

L. minor L.—B. $\frac{2}{4}$ / C.Hp / D.16.

L. racemulosa Lam.—B. $\frac{2}{4}$ / C.Hp / D.16.

L. tenuifolia Michx.—B. $\frac{2}{4}$ / C.Hp / D.16.

L. Leggettii Britt. & Holl.—B. $\frac{2}{4}$ / C.Hp / D.16.

89. *Violaceae*

A. Genera: 2. Species: 30. B. $\frac{2}{4}$ / 27, ② / 2, ① / 3. C. H / 29, Th / 1. D. 14 / 22,
16 / 7, 18 / 1.

Hybanthus concolor (Forst.) Spreng.—B. $\frac{2}{4}$ / C.Hp / D.16.

Viola pedata L.—B. $\frac{2}{4}$ / C.Hr / D.14.

var. *lineariloba* DC.

V. pedatifida Don.—B. $\frac{2}{4}$ / C.Hr / D.14.

V. triloba Schwein.—B. $\frac{2}{4}$ / C.Hr / D.14.

var. *dilatata* (Ell.) Brainerd

V. cuculata Ait.—B. $\frac{2}{4}$ / C.Hr / D.14.

x *V. fastata* House—B. $\frac{2}{4}$ / C.Hr / D.14.

- V. missouriensis* Greene—B. 2f / C. Hr / D.14.
V. papilionacea Pursh—B. 2f / C.Hr / D.14.—(Pl. 4, Fig. 35).
xV. napae House—B. 2f / C.Hr / D.14.
xV. variabilis Greene—B. 2f / C.Hr / D.14.
V. affinis LeConte—B. 2f / C.Hr / D.14.
V. sororia Willd.—B. 2f / C.Hr / D.14.
V. hirsutula Brainerd—B. 2f / C.Hr / D.14.
xV. cordifolia (Nutt.) Schwein.—B. 2f / C.Hr / D.14.
xV. dissita House—B. 2f / C.Hr / D.14.
V. sagitata Ait.—B. 2f / C.Hr / D.14.
 var. *ovata* T.&G.
V. lanceolata L.—B. 2f / C.Hrr / D.14.
V. primulifolia L.—B. 2f / C.Hrr / D.14.
V. pallens (Banks) Brainerd—B. 2f / C.Hrr / D.14.
V. blanda Willd.—B. 2f / C.Hrr / D.14.
V. incognita var. *Forbesii* Brainerd—B. 2f / C.Hrr / D.14.
V. eriocarpa Schwein.—B. 2f / C.Hr / D.14.
 f. *leiocarpa* Fern. & Wieg.
V. pubescens Ait.—B. 2f / C.Hr / D.14.
V. canadensis L.—B. 2f / C.Hs / D.16.
V. Rafinesquii Greene—B. ① / C.Th / D.18.
**V. tricolor* L.—B. ②, ① / C.Hs / D.16.
**V. arvensis* Murr.—B. ②, ① / C.Hs / D.16.
V. striata Ait.—B. 2f / C.Hs / D.16.
V. conspersa Reich.—B. 2f / C.Hs / D.16.
V. rostrata Pursh—B. 2f / C.Hs / D.16.

90. *Passifloraceae*

- A. Genera: 1. Species: 2. B. 2f / 2. C. H / 2. D. 15 / 2.
Passiflora lutea L.—B. 2f / C.Hp / D.15.
P. incarnata L.—B. 2f / C.Hp / D.15.

91. *Cactaceae*

- A. Genera: 1. Species: 1. B. 2f / 1. C. S / 1.
Opuntia humifusa Raf.—B. 2f / C.S.

92. *Thymelaeaceae*

- A. Genera: 1. Species: 1. B. ½ / 1. C. M / 1. D. 4 / 1.
Dirca palustris L.—B. ½ / C.N / D.4.

93. *Elaeagnaceae*

- A. Genera: 1. Species: 1. B. ½ / 1. C. N / 1. D. 4 / 1.
Shepherdia canadensis (L.) Nutt.—B. ½ / C.N / D.4.

94. *Lythraceae*

- A. Genera: 6. Species: 7. B. 2f / 4. ① / 3. C. Ch / 1. H / 2. HH / 1. Th / 3.
 D. 9 / 1. 16 / 3. 18 / 3.

- Rotula ramosior* (L.) Koehne var. *typica* Fern. & Griscom B.① / C.Th / D.18.
 var. *interior* Fern. & Griscom
Ammannia coccinea Rottb.—B.① / C.Th / D.18.
Didiplis diandra (Nutt.) Wood.—B.2f / C.HH / D.16.
Lythrum alatum Pursh.—B.2f / C.Hpr / D.16.
 **L. Salicaria* L.—B.2f / C.Hpr / D.16.
Cuphea petiolata (L.) Koehne.—B.① / C.Th / D.18.
Decodon verticillatus (L.) Ell.—B.2f / C.Ch / D.9.
 var. *laevigatus* T.&G.

95. *Melastomaceae*

- A. Genera: 1. Species: 2. B. 2f / 2. C. G/2. D. 17/2.
Rhexia mariana L. var. *leiocarpa* Fern. & Griscom—B.2f / C.Gr / D.17.
R. virginica L.—B.2f / C.Gr / D.17.—(Pl. 6, Fig. 1).

96. *Onagraceae*

- A. Genera: 6. Species: 29. B. 2f / 20, ②/8, ①/1. C. H/25, G/2, HH/1,
 Th/1. D. 14/1, 16/25, 17/2, 18/1.
Jussiaea decurrens (Walt.) DC.—B.2f / C.Hp / D.16.
J. diffusa Forsk.—B.2f / C.Hpr / D.16.
Ludvigia palustris var. *americana* (DC.) Fern. & Griscom—B.2f / C.Hpr / D.16.
L. alternifolia L.—B.2f / C.Hp / D.16.
L. glandulosa Walt.—B.2f / C.Hp / D.16.
L. polycarpa Short & Peter—B.2f / C.Hpr / D.16.
L. sphaerocarpa Ell.—B.2f / C.HH / D.16.
Epilobium angustifolium L.—B.2f / C.Hp / D.16.
E. strictum Muhl.—B.2f / C.Hpr / D.16.
E. densum Raf.—B.2f / C.Hp / D.16.
E. coloratum Muhl.—B.2f / C.Hs / D.16.
E. glandulosum var. *adenocaulon* (Haussk.) Fern.—B.2f / C.Hs / D.16.
Oenothera pycnocarpa Atkinson & Bartlett—B.② / C.Hs / D.16.
O. nutans Atkinson & Bartlett—B.② / C.Hs / D.16.
O. canovirens Steele—B.② / C.Hs / D.16.
O. cymatilis Bartlett—B.② / C.Hs / D.16.
O. rhombipetala Nutt.—B.② / C.Hs / D.16.
O. laciniata Hill—B.① / C.Th / D.18.
O. pilosella Raf. var. *longistipata* (Pennell) Munz—B.2f / C.Hs / D.16.
O. tetragona Roth.—B.2f / C.Hs / D.16.
O. perennis L.—B.2f / C.Hs / D.16.
O. speciosa Nutt.—B.2f / C.Hs / D.16.
O. triloba Nutt.—B.2f / C.Hr / D.14.
Gaura parviflora Dougl.—B.② / C.Hs / D.16.
G. biennis L.—B.② / C.Hs / D.16.
G. coccinea Pursh.—B.② (?) / C.Hs / D.16.
G. filipes var. *major* T.&G.—B.2f / C.Hs / D.16.
Circaea latifolia Hill—B.2f / C.Gr / D.17.
C. alpina L.—B.2f / C.Gr / D.17.

97. *Haloragidaceae*

- A.* Genera: 3. Species: 6. *B.* 2f / 6. *C.* HH / 6. *D.* 19 / 6.
Myriophyllum exalbescent Fern.—*B.* 2f / *C.* HH / *D.* 19.
M. heterophyllum Michx.—*B.* 2f / *C.* HH / *D.* 19.
M. scabratum Michx.—*B.* 2f / *C.* HH / *D.* 19.
M. verticillatum var. *pectinatum* Wallr.—*B.* 2f / *C.* HH / *D.* 19.
Proserpinaca palustris var. *amblyogona* Fern.—*B.* 2f / *C.* HH / *D.* 19.
var. *crebra* Fern. & Griscom
Hippuris vulgaris L.—*B.* 2f / *C.* HH / *D.* 19.

98. *Araliaceae*

- A.* Genera: 2. Species: 6. *B.* 7 / 1, 2f / 5. *C.* M / 1, Ch / 1, H / 2, G / 2. *D.* 4 / 1, 7 / 2, 9 / 1, 16 / 2, 17 / 2.
Aralia nudicaulis L.—*B.* 2f / *C.* Hpr / *D.* 16.
A. spinosa L.—*B.* 7 / *C.* M / *D.* 4, 7.
A. hispida Vent.—*B.* 2f / *C.* Ch / *D.* 7, 9.
A. racemosa L. *B.* 2f / *C.* Hpr / *D.* 16.
Panax quinquefolium L.—*B.* 2f / *C.* Grh / *D.* 17.—(Pl. 1, Figs. 4-6).
P. trifolium L.—*B.* 2f / *C.* Grh / *D.* 17.—(Pl. 1, Figs. 7, 8).

99. *Umbelliferae*

- A.* Genera: 25. Species: 35. *B.* 2f / 29, ② / 2 (+2), ① / 4. *C.* H / 25, G / 4, HH / 2, Th / 4. *D.* 14 / 2, 16 / 25, 17 / 4, 18 / 4.
Hydrocotyle umbellata L.—*B.* 2f / *C.* Hrr / *D.* 14.
H. americana L.—*B.* 2f / *C.* Hrr / *D.* 14.
Sanicula marilandica L.—*B.* 2f / *C.* Hs / *D.* 16.
S. gregaria Bickn.—*B.* 2f / *C.* Hs / *D.* 16.
S. canadensis L.—*B.* 2f, ② / *C.* Hs / *D.* 16.
S. trifoliata Bickn.—*B.* 2f, ② / *C.* Hs / *D.* 16.
Eryngium aquaticum L.—*B.* 2f / *C.* Grh / *D.* 17.
Chaerophyllum procumbens (L.) Crantz—*B.* ① / *D.* Th / *D.* 18.
var. *Shortii* T.&G.
Chaerophyllum Tainturieri Hook.—*B.* ① / *C.* Th / *D.* 18.
Osmorhiza Claytoni (Michx.) Clarke—*B.* 2f / *C.* Hs / *D.* 16.
O. longistylis (Torr.) DC.—*B.* 2f / *C.* Hs / *D.* 16.
var. *villicaulis* Fern.—var. *brachycoma* Blake
**Torilis Anthriscus* (L.) Bernh.—*B.* ① / *C.* Th / *D.* 18.
Erigenia bulbosa (Michx.) Nutt.—*B.* 2f / *C.* Grt / *D.* 17.—(Pl. 1, Fig. 1).
**Conium maculatum* L.—*B.* 2f *C.* Hs / *D.* 16.
**Bupleurum rotundifolium* L.—*B.* ① / *C.* Th / *D.* 18.
Zizia aurea (L.) Koch.—*B.* 2f / *C.* Hs / *D.* 16.
Z. cordata (Walt.) DC.—*B.* 2f / *C.* Hs / *D.* 16.
Cicuta bulbifera L.—*B.* 2f / *C.* Hs / *D.* 16.
C. maculata L.—*B.* 2f / *C.* Hs / *D.* 16.—(Pl. 2, Figs. 14, 15).
Cryptotaenia canadensis (L.) DC.—*B.* 2f / *C.* Hs / *D.* 16.
**Carum Carvi* L.—*B.* ② / *C.* Hs / *D.* 16.
Taenidia integerrima (L.) Drude—*B.* 2f / *C.* Hp / *D.* 16.

- Eulophus americanus* Nutt.—B. 2f / C.Grt / D.17.
Sium suave Walt.—B. 2f / C.HH / D.16.
Ligusticum canadense (L.) Britt.—B. 2f / C.Hs / D.16.
Thaspium trifoliatum var. *flavum* Blake—B. 2f / C.Hs / D.16.
T. barbinode (Michx.) Nutt.—B. 2f / C.Hs / D.16.
Conioselinum chinense (L.) BSP.—B. 2f / C.Hs / D.16.
Angelica villosa (Walt.) BSP.—B. 2f / C.Hs / D.16.
A. atropurpurea L.—B. 2f / C.Hs / D.16.
Polytaenia Nuttallii DC.—B. 2f / C.Hs / D.16.
Oxypolis rigidior (L.) Raf.—B. 2f / C.HH / D.16. (Pl. 2, Figs. 10-13).
**Pastinaca sativa* L.—B. ② / C.Hs / D.16.
Heracleum lanatum Michx.—B. 2f / C.Grt / D.17.
**Daucus Carota* L.—B. 2f / C.Hs / D.16.

100. *Cornaceae*

- A. Genera : 2. Species: 12. B. 1/2, 1/9, 2f/1. C. MM/2, M/7, N/2, H/1. C. MM/2, M/7, N/2, H/1. D. 2/2, 4/9, 16/1.
Nyssa sylvatica Marsh. var. *typica* Fern.—B. 1/ / C.MM / D.2.
 var. *caroliniana* (Poir.) Fern.
Cornus canadensis L.—B. 2f / C.Hpr / D.16.
C. florida L.—B. 1/ / C.MM / D.2.
C. alternifolia L.f.—B. 1/ / C.M / D.4.
C. rugosa Lam.—B. 1/ / C.M / D.4.
C. Bayleyi Coult. & Evans—B. 1/ / C.N / D.4.
C. asperifolia Michx.—B. 1/ / C.M / D.4.
C. stolonifera Michx.—B. 1/ / C.M / D.4.
C. racemosa Lam.—B. 1/ / C.N / D.4.
C. stricta Lam.—B. 1/ / C.M / D.4.
C. obliqua Raf.—B. 1/ / C.M / D.4.
C. Amomum Mill.—B. 1/ / C.M / D.4.

101. *Ericaceae*

- A. Genera: 12. Species: 24. B. 1/1, 1/15, 2f/8. C. MM/1, M / N/8, Ch/5, H/7, G/2. D. 2/1, 3/6, 4/7, 14/4, 16/2, 17/2, 20/2.
Chimaphila maculata (L.) Pursh—B. 2f / C.Hpr / D.16.
C. umbellata var. *cisatlantica* Blake—B. 2f / C.Hpr / D.16.
Pyrola elliptica Nutt.—B. 2f / C.Hrr / D.14.
P. chlorantha Sw.—B. 2f / C.Hrr / D.14.
P. rotundifolia var. *americana* (Sweet) Fern.—B. 2f / C.Hrr / D.14.
P. asarifolia var. *incarnata* (Fisch.) Fern.—B. 2f / C.Hrr / D.14.
Monotropa uniflora L.—B. 2f / C.Gr / D. 17, 20.
M. Hypopitys var. *rubra* (Torr.) Farw.—B. 2f / C.Gr / D. 17, 20.
Kalmia latifolia L.—B. 1/ / C.M / D.3.
Andromeda glaucophylla Link—B. 1/ / C.N (Ch) / D.3.
Chamaedaphne calyculata (L.) Moench.—B. 1/ / C.N / D.3.
Oxydendrum arboreum (L.) DC.—B. 1/ / C.MM / D.2.
Epigaea repens L.—B. 1/ / C.Ch / D.3.
Gaultheria procumbens L.—B. 1/ / D.Hpr / D.3.

- Arctostaphylos Uva-ursi* var. *coactilis* Fern. & Macbride—B. ① / C.Ch / D.3.
Gaylussica baccata (Wang.) K.Koch—B. ① / C.N / D.4.
 var. *leucocarpa* (Porter) Fern.
Vaccinium stamineum L.—B. ① / C.N / D.4.
 var. *neglectum* (Small) Deam
V. arboreum Marsh.—B. ① / C.M / D.4.
V. corymbosum L.—B. ① / C.N D.4.
 var. *amoenum* (Ait.) Gray—var. *pallidum* (Ait.) Gray—var. *atrocarpum* Gray
V. pennsylvanicum Lam.—B. ① / C.N / D.4.
 var. *nigrum* Wood.
V. vacillans Kalm—B. ① / C.N / D.4.
 var. *crinitum* Fern.
V. canadense Kalm—B. ① / C.N / D.4.
V. macrocarpon Ait.—B. ① / C.Ch / D.3.
V. Oxycoccus L.—B. ① / C.Ch / D.3.

102. *Primulaceae*

- A. Genera: 9. Species: 15. B. 2①/12, ①/3. C. Ch/1, H/9, HH/2, Th/3.
 D. 12/1, 14/1, 16/9, 18/3, 19/1.
Androsace occidentalis Pursh—B. ① / C.Th / D.18.
Hottonia inflata Ell.—B. 2① / C.HH / D.19.
Samolus parviflorus Raf.—B. 2① / C.Hs / D.16.
 **Lysimachia Nummularia* L.—B. 2① / C.Ch / D.12.
L. thyrsiflora L.—B. 2① / C.HH / D.16.
L. quadrifolia L.—B. 2① / C.Hpr / D.16.
L. terrestris (L.) BSP.—B. 2① / C.Hpr / D.16.
Steironema ciliatum Raf.—B. 2① / C.Hpr / D.16.
S. lanceolatum (Walt.) Gray—B. 2① / C.Hpr / D.16.
S. heterophyllum Michx.—B. 2① / C.Hpr / D.16.
S. quadriflorum (Sims) Hitchc. B. 2① / C.Hpr / D.16.
Trientalis borealis Raf.—B. 2① / C.Hpr / D.16.
 **Anagallis arvensis* L.—B. ① / C.Th / D.18.
Centunculus minimus L.—B. ① / C.Th / D.18.
Dodocatheon Meadia L.—B. 2① / C.Hr / D.14.

103. *Sapotaceae*

- A. Genera: 1. Species: 1. B. ① / 1, ① / 1. C. M/1, N/1. D. 2/1, 4/1, 7/1.
Bumelia lycioides (L.) Pers.—B. ①, ① / C. N, M / D. 2, 4, 7.

104. *Ebenaceae*

- A. Genera: 1. Species: 1. B. ① / 1. C. MM/1. D. 2/1.
Diospyros virginiana L.—B. ① / C.MM / D.2.

105. *Styracaceae*

- A. Genera: 1. Species: 1. B. ① / 1. C. M/1. D. 4/1.
Styrax americana Lam.—B. ① / C.M / D.4.

106. *Oleaceae*

- A.* Genera: 2. Species: 8. *B.* 1/8, 1/1. *C.* MM/7, M/1. *D.* 2/8, 4/1.
Fraxinus americana L.—*B.* 1/ / *C.* MM / *D.* 2.
F. biltmoreana Beadle—*B.* 1/ / *C.* MM / *D.* 2.
F. lanceolata Borkh.—*B.* 1/ / *C.* MM / *D.* 2.
F. pennsylvanica Marsh.—*B.* 1/ / *C.* MM / *D.* 2.
F. profunda Bush—*B.* 1/ / *C.* MM / *D.* 2.
var. *Ashei* Palmer
F. quadrangulata Michx.—*B.* 1/ / *C.* MM / *D.* 2.
F. nigra L.—*B.* 1/ / *C.* MM / *D.* 2.
Forestiera acuminata (Michx.) Poir.—*B.* 1/ , 1/ / *C.* M / *D.* 2,4.

107. *Loganiaceae*

- A.* Genera: 1. Species: 1. *B.* 21/1. *C.* H/1. *D.* 16/1.
Spigelia marilandica L.—*B.* 21/ / *C.* Hp / *D.* 16.

108. *Gentianaceae*

- A.* Genera: 6. Species: 14. *B.* 21/8, ②/4(+1), ①/2 (+4). *C.* H/11, HH/1, Th/2. *D.* 16/12, 18/2.
Sabatia angularis (L.) Pursh—*B.* ②, ① / *C.* Hs / *D.* 16.
S. gracilis (Michx.) Salisb.—*B.* ②, ① / *C.* Hs / *D.* 16.
Bartonia virginica (L.) BSP.—*B.* ②, ① / *C.* Hp / *D.* 16.
Obolaria virginica L.—*B.* 21/ / *C.* Hp / *D.* 16.
Gentiana crinita Froel.—*B.* ②, ① / *C.* Hp / *D.* 16.
G. procera Holm—*B.* ① / *C.* Th / *D.* 18.
f. *laevicalyx* Fern.
G. quinquefolia L.—*B.* ① / *C.* Th / *D.* 18.
G. Andrewsii Griseb.—*B.* 21/ / *C.* Hp / *D.* 16.
G. Saponaria L.—*B.* 21/ / *C.* Hpr / *D.* 16.
G. puberula Michx.—*B.* 21/ / *C.* Hp / *D.* 16.
G. flavida Gray—*B.* 21/ / *C.* Hp / *D.* 16.
G. villosa L.—*B.* 21/ / *C.* Hp / *D.* 16.
Frasera carolinensis Walt.—*B.* 21/ , ② / *C.* Hs / *D.* 16.
Menyanthes trifoliata var. *minor* Raf.—*B.* 21/ / *C.* HH / *D.* 16.

109. *Apocynaceae*

- A.* Genera: 4. Species: 7. *B.* 1/1, 21/6. *C.* M/1, Ch/1, H/5. *D.* 5/1, 12/1, 16/5.
Amsonia Tabernaemontana var. *salicifolia* (Pursh) Wood—*B.* 21/ / *C.* Hp / *D.* 16.
**Vinca minor* L.—*B.* 21/ / *C.* Ch / *D.* 12.
Trachelospermum difforme (Walt.) Gray—*B.* 1/ / *C.* M / *D.* 5.
Apocynum androsaemifolium L.—*B.* 21/ / *C.* Hp / *D.* 16.
A. medium Greene—*B.* 21/ / *C.* Hp / *D.* 16.
var. *sarriense* (Greene) Woodson—var. *leuconeuron* (Greene) Woodson
A. cannabinum L.—*B.* 21/ / *C.* Hp / *D.* 16.

- var. *pubescens* (Mitchell) A.DC.—var. *glaberrimum* A.DC.
A. hypericifolium Ait.—B. 2f / C.Hp / D.16.
 var. *Farwellii* (Greene) Woodson

110. *Asclepiadaceae*

- A.* Genera: 4. Species: 17. B. 2f / 17. C. H/15, G/2. D. 15/3, 16/13, 17/1.
Acerates hirtella Pennell—B. 2f / C.Hp / D.16.
A. viridiflora (Raf.) Eaton—B. 2f / C.Hp / D.16.
Asclepias verticillata L.—B. 2f / C.Hp / D.16.
A. tuberosa L.—B. 2f / C.Hp / D.16.
 f. *bicolor* Standley
A. Meadii Torr.—B. 2f / C.Hp / D.16.
A. amplexicaulis J.E.Smith—B. 2f / C.Hp / D.16.
A. Sullivantii Engelm.—B. 2f / C.Hs / D.16.
A. incarnata L.—B. 2f / C.Hp / D.16.
A. quadrifolia Jacq.—B. 2f / C.Hp / D.16.
A. perennis Walt.—B. 2f / C.Hp / D.16.
A. variegata L.—B. 2f / C.Hp / D.16.
A. phytolaccoides Pursh—B. 2f / C.Hp / D.16.
A. syriaca L.—B. 2f / C. Grh / D.17.
A. purpurascens L.—B. 2f / C.Hp / D.16.
Vincetoxicum gonocarpus Walt.—B. 2f / C.Hp / D.15.
V. Shortii (A.Gray) Britt.—B. 2f / C.Hp / D.15.
Gonolobus laevis Michx.—B. 2f / C.Gr / D. 15, 17.

111. *Convolvulaceae*

- A.* Genera: 4. Species: 18. B. 2f / 5, ① / 13. C. H/3, G/2, Th/13. D. 15/2, 16/1, 17/2, 18/13.
Cuscuta cuspidata Engelm.—B. ① / C.Th / D. 18, 20.
C. glomerata Choisy—B. ① / C.Th / D. 18, 20.
C. compacta Juss.—B. ① / C. Th / D. 18, 20.
C. pentagona Engelm.—B. ① / C.Th / D. 18, 20.
C. campestris Yunker—B. ① / C.Th / D. 18, 20.
C. Gronovii Willd.—B. ① / C. Th / D. 18, 20.
 var. *calyptata* Engelm.
C. Cephalanthi Engelm.—B. ① / C.Th / D. 18, 20.
C. Coryli Engelm.—B. ① / C.Th / D. 18, 20.
C. Polygonorum Engelm.—B. ① / C. Th / D. 18, 20.
Convolvulus spithameus L.—B. 2f / C.Hp / D.16.
**C. japonicus* Thunb.—B. 2f / C.Hp / D.15.
C. repens L.—B. 2f / C.Hp / D.15.
**C. arvensis* L.—B. 2f / C.Gr / D.17.
Ipomoea lacunosa L.—B. ① / C.Th / D.18.
I. pandurata (L.) G.F.W.Mey.—B. 2f / C.Grt / D.17.
 var. *rubescens* Choisy
**I. hederacea* Jacq.—B. ① / C.Th / D.18.
**I. purpurea* (L.) Roth.—B. ① / C.Th / D.18.
**Quamoclit coccinea* (L.) Moench.—B. ① / C.Th / D.18.

112. *Polemoniaceae*

- A. Genera: 3. Species: 12. B. 2f / 11, ② / 1. C. Ch / 2, H / 10. D. 9 / 2, 16 / 1C.
Phlox glaberrima L.—B. 2f / C.Hp / D.16.
P. carolina var. *triflora* (Michx.) Wherry—B. 2f / C.Hpr / D.16.
P. maculata L.—B. 2f / C.Hp / D.16.
P. pilosa L.—B. 2f / C.Hp / D.16.
 var. *fulgida* Wherry—var. *amplexicaulis* (Raf.) Wherry
P. bifida Beck—B. 2f / C.Hpr / D.16.
P. ovata L.—B. 2f / C.Hp / D.16.
P. amplifolia Britt.—B. 2f / C.Hp / D.16.
P. paniculata L.—B. 2f / C.Hp / D.16.
P. subulata A.Gray—B. 2f / C.Ch / D.9.
P. divaricata L.—B. 2f / C. Ch / D.9.
Polemonium reptans L.—B. 2f / C.Hp / D.16.
**Ipomopsis rubra* (L.) Wherry—B. ② / C.Hs / D.16.

113. *Hydrophyllaceae*

- A. Genera: 3. Species: 8. B. 2f / 3, ② / 2, ① / 3. C. H / 4, G / 1, Th / 3. D. 16 / 4, 17 / 1, 18 / 3.
Hydrophyllum appendiculatum Michx.—B. ② / C.Hs / D.16.
H. canadense L.—B. 2f / C. Grh / D.17.—(Pl. 6, Fig. 4).
H. virginianum L.—B. 2f / C.Hsr / D.16.
H. macrophyllum Nutt.—B. 2f / C.Hs / D.16.
Ellisia Nyctelea L.—B. ① / C.Th / D.18.
Phacelia bipinnatifida Michx.—B. ② / C.Hp / D.16.
P. Covillei S. Wats.—B. ① / C.Th / D.18.
P. Purshii Buckley—B. ① / C.Th / D.18.

114. *Boraginaceae*

- A. Genera: 9. Species: 17. B. 2f / 10, ② / 5 (+1), ① / 2 (+3). C. H / 15, Th / 2. D. 16 / 15, 18 / 2.
**Heliotropium indicum* L.—B. ① / C.Th / D.18.
**Cynoglossum officinale* L.—B. ② / C.Hs / D.16.
C. virginianum L.—B. 2f / C.Hs / D.16.
**Lappula echinata* Gilib.—B. ① / C.Th / D.18.
Hackelia virginiana (L.) Johnson—B. ② / C.Hs / D.16.
**Myostis scorpioides* L.—B. 2f / C.Hpr / D.16.
M. laxa Lehm.—B. 2f / C.Hpr / D.16.
M. virginica (L.) BSP.—B. ②, ① / C.Hs / D.16.
 var. *macrocarpa* (Engelm.) Fern.
M. micrantha Pall.—B. ①, ② / C.Hs / D.16.
Mertensia virginica (L.) Link.—B. 2f / C.Hs / D.16.
**Lithospermum arvense* L.—B. ②, ① / C.Hs / D.16.
L. latifolium Michx.—B. 2f / C.Hp / D.16.
L. incisum Lehm.—B. 2f / C.Hp / D.16.
L. canescens (Michx.) Lehm.—B. 2f / C.Hp / D.16.
L. croceum Fern.—B. 2f / C.Hp / D.16.
Onosmodium hispidissimum Mack.—B. 2f / C.Hs / D.16.
**Echium vulgare* L.—B. 2f, ② / C.Hs / D.16.

115. *Verbenaceae*

A. Genera: 2. Species: 10. B. 2f / 10. C. H / 10. D. 16 / 10.

Verbena canadensis (L.) Britt.—B. 2f / C.Hpr / D.16.

V. urticaefolia L.—B. 2f / C.Hp / D.16.

var. *leiocarpa* Perry & Fern.

V. hastata L.—B. 2f / C.Hp / D.16.

V. simplex Lehm.—B. 2f / C.Hp / D.16.

V. stricta Vent.—B. 2f / C.Hp / D.16.

V. bracteata Lag. & Rodr.—B. 2f / C.Hp / D.16.

x *V. Rydbergii* Moldenke—B. 2f / C.Hp / D.16.

x *V. moenchina* Moldenke—B. 2f / C.Hp / D.16.

x *V. Perriana* Moldenke—B. 2f / C.Hp / D.16.

Lippia lanceolata var. *recognita* Fern. & Griscom—B. 2f / C.Hpr / D.16.

116. *Labiatae*

A. Genera: 26. Species: 61. B. 2f / 53, ②/2, ①/8 (+1). C. H / 52, G / 3, Th / 8.
D. 16 / 52, 17 / 3, 18 / 8.

Teucrium canadense L.—B. 2f / C.Hpr / D.16.

var. *virginicum* (L.) Eaton

T. occidentale Gray—B. 2f / C.Hpr / D.16.

var. *boreale* (Bickn.) Fern.

Isanthus brachiatus (L.) BSP.—B. ① / C.Th / D.18.

Trichostema dichotomum L.—B. ① / C.Th / D.18.

Scutellaria parvula Michx.—B. 2f / C.Gst / D.17.—(Pl. 6, Fig. 2).

var. *ambigua* Nutt.

S. epilobifolia Hamilt.—B. 2f / C.Hpr / D.16.

S. nervosa Pursh—B. 2f / C.Hpr / D.16.

S. lateriflora L.—B. 2f / C.Hpr / D.16.

S. saxatilis Riddell—B. 2f / C.Hpr / D.16.

S. incana Spreng.—B. 2f / C.Hp / D.16.

S. ovalifolia Pers.—B. 2f / C.Hp / D.16.

S. ovata Hill—B. 2f / C.Hpr / D.16.

**Marrubium vulgare* L.—B. 2f / C.Hp / D.16.

Agastache nepetoides (L.) Ktze.—B. 2f / C.Hs / D.16.

A. scrophulariaefolia (Willd.) Ktze.—B. 2f / C.Hs / D.16.

**Nepeta Cataria* L.—B. 2f / C.Hp / D.16.

**Glechoma hederacea* L.—B. 2f / C.Hpr / D.16.

var. *parviflora* (Benth.) House

**Prunella vulgaris* L.—B. 2f / C.Hsr / D.16.

var. *lanceolata* (Bart.) Fern.

Physostegia speciosa Sweet—B. 2f / C.Hp / D.16.

P. virginiana (L.) Benth.—B. 2f / C.Hp / D.16.

Synandra hispidula (Michx.) Britt.—B. ② / C.Hp / D.16.

**Lamium amplexicaule* L.—B. ②, ① / C.Hp / D.16.

**L. purpureum* L.—B. ① / C.Th / D.18.

**Leonurus Cardiaca* L.—B. 2f / C.Hp / D.16.

Stachys hyssopifolia Michx.—B. 2f / C.Hpr / D.16.

S. aspera Michx.—B. 2f / C.Hpr / D.16.

- S. palustris* var. *homotricha* Fern.—B. 2f / C.Gst / D.17.
S. Riddellii House—B. 2f / C.Hpr / D.16.
S. tenuifolia Willd.—B. 2f / C.Hpr / D.16.
S. hispida Pursh—B. 2f / C.Hpr / D.16.
S. Clingmanii Small—B. 2f / C.Hpr / D.16.
Salvia lyrata L.—B. 2f / C.Hs / D.16.
S. lanceaefolia Poir.—B. ① / C.Th / D.18.
Monarda Bradburiana Beck—B. 2f / C.Hpr / D.16.
M. clinopodia L.—B. 2f / C.Hpr / D.16.
M. fistulosa L.—B. 2f / C.Hpr / D.16.
 var. *mollis* (L.) Benth.
M. punctata var. *villicaulis* Pennell—B. 2f / C.Hpr / D.16.
Blephilia ciliata (L.) Raf.—B. 2f / C.Hpr / D.16.
B. hirsuta (Pursh) Benth.—B. 2f / C.Hpr / D.16.
Hedeoma pulegioides (L.) Pers.—B. ① / C.Th / D.18.
H. hispida Pursh—B. ① / C.Th / D.18.
**Melissa officinalis* L.—B. 2f / C.Hpr / D.16.
**Satureja hortensis* L.—B. ① / C.Th / D.18.
S. vulgaris (L.) Fritsch—B. 2f / C.Hpr / D.16.
S. glabra (Nutt.) Fern.—B. 2f / C.Hpr / D.16.
Pycnanthemum pycnanthemoides (Leavenw.) Fern.—B. 2f / C.Hpr / D.16.
P. flexuosum (Walt.) BSP.—B. 2f / C.Hpr / D.16.
P. pilosum Nutt.—B. 2f / C.Hpr / D.16.
P. virginianum (L.) Durand & Jackson—B. 2f / C.Hpr / D.16.
Cunila origanoides (L.) Britt.—B. 2f / C.Hp / D.16.—(Pl. 4, Figs. 30, 31).
Lycopus uniflorus Michx.—B. 2f / C.Hpr / D.16.
L. virginicus L.—B. 2f / C.Hpr / D.16.
L. sessilifolius Gray—B. 2f / C.Hpr / D.16.
L. rubellus Moench.—B. 2f / C.Hpr / D.16.
L. americanus Muhl.—B. 2f / C.Hpr / D.16.
 var. *Longii* Benner
**Mentha spicata* L.—B. 2f / C.Hpr / D.16.
**M. piperita* L.—B. 2f / C.Hpr / D.16.
**M. longifolia* var. *molissima* Borkh.—B. 2f / C.Hpr / D.16.
**M. rotundifolia* L.—B. 2f / C.Hpr / D.16.
M. arvensis L.—B. 2f / C.Hpr / D.16.
 var. *sativa* Benth.
M. gentilis L.—B. 2f / C.Hpr / D.16.
Collinsonia canadensis L.—B. 2f / C.Gst / D.17.—(Pl. 3, Fig. 21).
**Perilla frutescens* var. *nanquinensis* Bailey—B. ① / C.Th / D.18.

117. *Solanaceae*

- A. Genera: 5. Species: 14. B. ½/2, 2f/6, ①/6. C. M/1, N/1, G/6, Th/6.
 D. 5/2, 7/2, 17/6, 18/6.
**Nicandra physalodes* (L.) Pers.—B. ① / C. Th / D.18.
Lycium halimifolium Mill.—B. ½ / C.M / D.5.
Physalis pubescens L.—B. ① / C.Th / D.18.
P. pruinosa L.—B. ① / C.Th / D.18.

- P. subglabrata* Mack. & Bush—B. 2f / C.Gr / D.17.
P. virginiana Mill.—B. 2f / C.Gr, Gr / D.17.
P. nyctaginea Dunal—B. 2f / C.Gr / D.17.
P. heterophylla Nees—B. 2f / C.Gr / D.17.
P. ambigua (A. Gray) Rydb.—B. 2f / C.Gr / D.17.
Solanum carolinense L.—B. 2f / C.Gr / D. 7, 17.
**S. rostratum* Dunal—B. ① / C.Th / D. 7, 18.
S. nigrum L.—B. ① / C.Th / D.18.
S. Dulcamara L.—B. 2 / C.N / D.5.
**Datura Stramonium* L.—B. ① / C.Th / D.18.

118. *Scrophulariaceae*

- A. Genera: 25. Species: 57. B. 1 / 1, 2f / 32, ② / 6 ① / 18 (+2). C. MM / 1
 Ch / 6, H / 31, G / 1, Th / 18. D. 2 / 1, 12 / 6, 16 / 31, 17 / 1, 18 / 18, 20 / 2.
**Verbascum Blattaria* L.—B. ② / C.Hs / D.16.
**V. phlomoides* L.—B. ② / C.Hs / D.16.
**V. Thapsus* L.—B. ② / C.Hs / D.16.
**Kickxia Elatine* (L.) Dumort.—B. ① / C.Th / D.18.
**Linaria vulgaris* Hill.—B. 2f / C.Hpr / D.16.
L. canadensis (L.) Dumort.—B. ① / C.Th / D.18.
**Chaenorhinum minus* (L.) Lange—B. ① / C.Th / D.18.
Collinsia verna Nutt.—B. ② / C.Hp / D.16.
Scrophularia marilandica L.—B. 2f / C.Hp / D.16.
S. lanceolata Pursh—B. 2f / C.Hp / D.16.
Chelone obliqua var. *speciosa* Pennell & Wherry—B. 2f / C.Hpr / D.16.
C. glabra L. var. *typica* Pennell & Wherry—B. 2f / C.Hpr / D.16.
 f. *tomentosa* (Raf.) Pennell—var. *elongata* Pennell & Wherry
 var. *linifolia* Coleman—f. *velutina* Pennell & Wherry—var. *elatio* Raf.
Pentstemon tubaeformis Nutt.—B. 2f / C.Hs / D.16.
P. calycosus Small—B. 2f / C.Hs / D.16.
P. Digitalis Nutt.—B. 2f / C.Hs / D.16.
P. alluviorum Pennell—B. 2f / C.Hs / D.16.
P. Deamii Pennell—B. 2f / C.Hs / D.16.
P. canescens (Britt.) Britt. var. *typicus*—B. 2f / C.Hs / D.16.
P. pallidus Small—B. 2f / C.Hs / D.16.
P. hirsutus (L.) Willd.—B. 2f / C.Hs / D.16.
**Paulownia tomentosa* (Thunb.) Steud.—B. 1 / C.MM / D.2.
Mimulus ringens L.—B. 2f / C.Hpr / D.16.
M. alatus Ait.—B. 2f / C.Hpr / D.16.
Gratiola virginiana L.—B. ① / C.Th / D.18.
G. neglecta Torr.—B. ① / C.Th / D.18.
Leucospora multifida (Michx.) Nutt.—B. ① / C.Th / D.18.
Hydranthelium rotundifolium (Michx.) Pennell—B. 2f / C.Ch / D.12
Lindernia dubia (L.) Pennell var. *typica*—B. ① / C.Th / D.18.
 var. *major* (Pursh) Pennell
L. anagallidea (Michx.) Pennell—B. ① / C.Th / D.18.
Veronica peregrina L. var. *typica*—B. ① / C.Th / D.18.
 var. *xalapensis* (HBK) Pennell

- *V. serpyllifolia* L.—B. 2f / C.Hp / D.16.
**V. arvensis* L.—B. ① / C.Th / D.18.
**V. persica* Poir.—B. ① / C.Th / D.18.
**V. officinalis* L.—B. 2f / C.Ch / D.12.
**V. Chamaedrys* L.—B. 2f / C.Ch / D.12.
V. scutellata L.—B. 2f / C.Hpr / D.16.
V. americana (Raf.) Schwein.—B. 2f / C.Ch / D.12.
V. glandifera Pennell—B. 2f / C.Ch / D.12.
V. connata Raf. var. *typica*—B. 2f / C.Ch / D.12.
Veronicastrum virginicum (L.) Farw.—B. 2f / C.Grh / D.17.
Besseyia Bullii (Eaton) Rydb.—B. 2f / C.Hsr / D.16.
Dasistoma macrophylla (Nutt.) Raf.—B. 2f / C.Hp / D.16.
Gerardia purpurea L.—B. ① / C.Th / D.18.
G. paupercula (Gray) Britt. var. *typica*—B. ① / C.Th / D.18.
 var. *borealis* (Pennell) Pennell
G. tenuifolia Vahl var. *typica*—B. ① / C.Th / D.18.
 var. *macrophylla* Benth.—var. *parviflora* Nutt.
G. Skinneriana Wood.—B. ① / C.Th / D.18.
G. Gattingeri Small—B. ① / C.Th / D.18.
Tomanthera auriculata (Michx.) Raf.—B. ① / C.Th / D. 18, 20.
Aureolaria flava (L.) Farw. var. *typica*—B. 2f / C.Hp / D.16.
A. virginica (L.) Farw.—B. 2f / C.Hp / D.16.
A. grandiflora var. *pulchra* Pennell—B. 2f / C.Hp / D.16.
A. pedicularia (L.) Raf. var. *typica*—B. ②, ① / C.Hp / D.16.
 var. *intercedens* Pennell—var. *ambigens* (Fern.) Farw.
Buchnera americana L.—B. 2f / C.Hpr / D.16.
Castilleja coccinea (L.) Spreng.—B. ②, ① / C.Hs / D. 16, 20.
Melampyrum lineare var. *latifolium* (Muhl.) Beauverd—B. ① / C.Th / D.18.
 var. *pectinatum* Pennell
Pedicularis canadensis L.—B. 2f / C.Hs / D.16.
P. lanceolata Michx.—B. 2f / C.Hs / D.16.

119. *Bignoniaceae*

- A.* Genera: 3. Species: 4. B. 1/2, 1/2 / 2. C. MM/4. D. 2/2, 5/2.
**Bignonia capreolata* L.—B. 1/2 / C.MM / D.5.
Campsis radicans (L.) Seem.—B. 1/2 / C.MM / D.5.
**Catalpa bignonioides* Walt.—B. 1/2 / C.MM / D.2.
C. speciosa Ward—B. 1/2 / C.MM / D.2.

120. *Martyniaceae*

- A.* Genera: 1. Species: 1. B. ① / 1. C. Th / 1. D. 18 / 1.
Martynia louisiana Mill.—B. ① / C.Th / D.18.

121. *Orobanchaceae*

- A.* Genera: 3. Species: 5. B. 2f / 5. C. Gp / 5. D. 17 / 5, 20 / 5.
Conopholis americana (L.f.) Wallr.—B. 2f / C.Gp / D. 17, 20.
Orobanche ludoviciana Nutt. var. *genuina*—B. 2f / C.Gp / D. 17, 20.
O. uniflora L. var. *typica*—B. 2f / C.Gp / D. 17, 20.

- O. fasciculata* Nutt. var. *typica*—B. 2f / C.Gp / D. 17, 20.
Epifagus virginiana (L.) Bart.—B. 2f / C.Gp / D. 17, 20.

122. *Lentibulariaceae*

- A. Genera: 1. Species: 9. B. 2f / 9. C. HH / 9. D. 19 / 9.
Utricularia purpurea Walt.—B. 2f / C.HH / D.19.
U. resupinata B.D.Greene—B. 2f / C.HH / D.19.
U. cornuta Michx.—B. 2f / C.HH / D.19.
U. gibba L.—B. 2f / C.HH / D.19.
U. intermedia Hayne—B. 2f / C.HH / D.19.
U. minor L.—B. 2f / C.HH / D.19.
U. macrorhiza LeConte—B. 2f / C.HH / D.19.
U. inflata Walt.—B. 2f / C.HH / D.19.
U. radiata Small—B. 2f / C.HH / D.19.
U. fibrosa Walt.—B. 2f / C.HH / D.19.

123. *Acanthaceae*

- A. Genera: 3. Species: 4. B. 2f / 3. ① / 1. C. G / 2, HH / 1, Th / 1. D. 16 / 1, 17 / 2, 18 / 1.
Ruellia caroliniensis (Walt.) Steud.—B. 2f / C.Gr / D.17.
 var. *parviflora* (Nees) Blake
R. strepens L.—B. 2f / C.Gr / D.17.
 f. *cleistantha* (Gray) McCoy
Diapedium brachiatum (Pursh) Kuntze—B. ① / C.Th / D.18.
Dianthera americana L.—B. 2f / C.HH / D.16.

124. *Phrymaceae*

- A. Genera: 1. Species: 1. B. 2f / 1. C. H / 1. D. 16 / 1.
Phryma leptostachya L.—B. 2f / C.Hp / D.16.

125. *Plantaginaceae*

- A. Genera: 1. Species: 8. B. 2f / 4. ② / 1 (+1). ① / 3 (+1). C. H / 5, Th / 3. D. 14 / 5, 18 / 3.
Plantago cordata Lam.—B. 2f / C.Hr / D.14.
P. major L.—B. 2f / C.Hr / D.14.
P. Rugelli Dcne.—B. 2f / C.Hr / D.14.
 var. *asperula* Farw.
P. aristata Michx.—B. ① / C.Th / D.18.
 **P. lanceolata* L.—B. 2f. ② / C.Hr / D.14.
 var. *sphaerostachya* f. *eriophora* Hoffm. & Link
P. Purshii R.&S.—B. ① / C.Th / D.18.
P. virginica L.—B. ②. ① / C.Hr / D.14.
P. elongata Pursh—B. ① / C.Th / D.18.

126. *Rubiaceae*

- A. Genera: 6. Species: 21. B. 7 / 1, 2f / 17, ① / 3. C. M / 1, Ch / 1, H / 16, Th / 3. D. 4 / 1, 12 / 1, 16 / 16, 18 / 3.
Houstonia caerulea L.—B. 2f / C.Hsr / D.16.
H. purpurea L.—B. 2f / C.Hs / D.16.

- f. pubescens* (Britt.) Fern.
H. longifolia Gaertn.—B. 2f / C.Hs / D.16.
H. angustifolia Michx.—B. 2f / C.Hs / D.16.
Cephalanthus occidentalis L.—B. ½ / C.M / D.4.
 var. *pubescens* Raf.
Mitchella repens L.—B. 2f / C.Ch / D.12.
Diodia teres Walt.—B. ① / C.Th / D.18.
Spermacoce glabra Michx.—B. 2f / C.Hp / D.16.
Galium circaezans Michx.—B. 2f / C.Hpr / D.16.
G. lanceolatum Torr.—B. 2f / C.Hp / D.16.
G. pilosum Ait.—B. 2f / C.Hp / D.16.
G. boreale L. var. *typicum*—B. 2f / C.Hpr / D.16.
 var. *intermedium* DC.—var. *hyssopifolium* (Hoffm.) DC.
G. Aparine L.—B. ① / C.Th / D.18.
G. triflorum Michx.—B. 2f / C.Hp / D.16.
**G. parisiense* L.—B. ① / C.Th / D.18.
G. concinnum T.&G.—B. 2f / C.Hp / D.16.
G. asprellum Michx.—B. 2f / C.Hp / D.16.
G. obtusum Bigel.—B. 2f / C.Hp / D.16.
G. labradoricum Wiegand—B. 2f / C.Hp / D.16.
G. trifidum L.—B. 2f / C.Hpr / D.16.
G. tinctorium L.—B. 2f / C.Hpr / D.16.

127. *Caprifoliaceae*

- A. Genera: 7. Species: 22. B. ½ / 18, 2f / 4. C. M / 11, N / 7, Ch / 1, H / 3.
 D. 4 / 18, 12 / 1, 16 / 3.
Sambucus canadensis L.—B. ½ / C.M / D.4.
 f. atrovavula House
S. pubens Michx.—B. ½ / C.M / D.4.
 f. calva Fern.—*f. xanthocarpa* Nieuwl.
Viburnum trilobum Marsh.—B. ½ / C.M / D.4.
V. acerifolium L.—B. ½ / C.N / D.4.
 f. ovatum Rehder
V. cassinoides L.—B. ½ / C.M / D.4.
V. Lentago L.—B. ½ / C.M / D.4.
V. prunifolium L.—B. ½ / C.M / D.4.
V. rufidulum Raf.—B. ½ / C.M / D.4.
V. affine Bush—B. ½ / C.N / D.4.
 var. *hypomalacum* Blake
V. molle Michx.—B. ½ / C.M / D.4.
V. pubescens var. *Deamii* Rehder—B. ½ / C.N / D.4.
 var. *indianense* Rehder
Triosteum perfoliatum L.—B. 2f / C.Hp / D.16.
T. aurantiacum Bickn.—B. 2f / C.Hp / D.16.
 var. *illinoense* (Wieg.) Palmer & Steyermark—var. *glaucescens* Wieg.
T. angustifolium L.—B. 2f / C.Hp / D.16.
Symphoricarpos orbiculatus Moench.—B. ½ / C.N / D.4.
S. albus var. *laevigatus* (Fern.) Blake—B. ½ / C.N / D.4.

Linnaea borealis var. *americana* (Forbes) Rehder—B. 2f / C.Ch / D.12.

Lonicera canadensis Marsh.—B. 1 / C.N / D.4.

**L. japonica* Thunberg—B. 1 / C.M / D.4.

L. dioica L.—B. 1 / C.M / D.4.

var. *glaucescens* (Rehder) Butters—f. *dasygyna* (Rehder) Deam

L. prolifera (Kirchner) Rehder—B. 1 / C.M / D.4.

Diervilla lonicera Mill.—B. 1 / C.N / D.4.

128. Valerianaceae

A. Genera: 2. Species: 5. B. 2f/2, ①/3. C. H/1, G/1, Th/3. D. 16/1, 17/1, 18/3.

Valerianella chenopodifolia (Pursh) DC.—B. ① / C.Th / D.18.

V. radiata (L.) DuRoi.—B. ① / C.Th / D.18.

var. *leiocarpa* (T.&G.) Krock.

**V. locusta* (L.) Betcke—B. ① / C.Th / D.18.

Valeriana pauciflora Michx.—B. 2f / C.Hsr / D.16.

V. edulis Nutt.—B. 2f / C.Grt / D.17.

129. Dipsacaceae

A. Genera: 1. Species: 1. B. ②/1. C. H/1. D. 16/1.

**Dipsacus sylvestris* Huds.—B. ② / C.Hs / D.16.

130. Cucurbitaceae

A. Genera: 3. Species: 3. B. 2f/1, ①/2. C. H/1, Th/2. D. 15/1, 18/2.

Melothria pendula L.—B. 2f / C.Hp / D.15.

Micrampelis lobata (Michx.) Greene—B. ① / C.Th / D.18.

Sicyos angulatus L.—B. ① / C.Th / D.18.

131. Campanulaceae

A. Genera: 2. Species: 5. B. 2f/3, ②/1, ①/1 (+1). C. H/4, Th/1. D. 16/4, 18/1.

Campanula americana L.—B. ②, ① / C.Hp / D.16.

C. uliginosa Rydb.—B. 2f / C.Hpr / D.16.

C. aparinoides Pursh—B. 2f / C.Hpr / D.16.

C. rotundifolia L.—B. 2f / C.Hpr / D.16.

var. *intercedens* (Witasek) Farw.

Specularia perfoliata (L.) A.DC.—B. ① / C.Th / D.18.

132. Lobeliaceae

A. Genera: 1. Species: 7. B. 2f/5, ②/2, ①/(1). C. H/7. D. 16/7.

Lobelia cardinalis L.—B. 2f / C.Hs / D.16.

f. *alba* (A.A.Eaton) St. John—B. 2f / C.Hs / D.16.

L. siphilitica L.—B. 2f / C.Hs / D.16.

f. *albiflora* (Britt.) House

L. puberula Michx.—B. 2f / C.Hs / D.16.

L. kalmii L.—B. 2f / C.Hs / D.16.

L. inflata L.—B. ② / C.Hs / D.16.

L. spicata var. *leptostachys* (A.DC.) Mack. & Bush—B. ②, ① / C.Hs / D.16.

var. *originalis* McVaugh—var. *campanulata* McVaugh

- L. spicata* Lam.—B. 2f / C.Hs / D.16.
var. *hirtella* Gray

133. *Compositae*

- A.* Genera: 66. Species: 255. *B.* 2f / 188, ② / 19 (+3), ① / 48 (+6). *C.* Ch / 10, H / 183, G / 13, HH / 1 (+1), Th / 48. *D.* 7 / 12, 9 / 2, 12 / 9, 14 / 3, 16 / 180, 17 / 12, 18 / 48, 19 / 1.
- Vernonia altissima* Nutt.—B. 2f / C.Hp / D.16.
var. *lilacina* Clute
- V. missurica* Raf.—B. 2f / C.Hp / D.16.
f. *carnea* Standley
- V. fasciculata* Michx.—B. 2f / C.Hp / D.16.
- Elephantopus carolinianus* Willd.—B. 2f / C.Hp / D.16.
- Eupatorium maculatum* L.—B. 2f / C.Hp / D.16.
- E. purpureum* L.—B. 2f / C.Hp / D.16.
- E. trifoliatum* L.—B. 2f / C.Hp / D.16.
- E. serotinum* Michx.—B. 2f / C.Hp / D.16.
- E. altissimum* L.—B. 2f / C.Hp / D.16.
- E. sessifolium* L.—B. 2f / C.Hp / D.16.
- E. perfoliatum* L.—B. 2f / C.Hp / D.16.
f. *truncatum* (Muhl.) Fassett—var. *cuneatum* Engelm.—f. *purpureum* Britt
- E. urticaefolium* Reichard.—B. 2f / C.Hp / D.16.
- E. incarnatum* Walt.—B. 2f / C.Hp / D.16.
- E. coelestinum* L.—B. 2f / C.Hp / D.16.
- Mikania scandens* (L.) Willd.—B. 2f / C.Grh (HH) / D. 17 (16).
- Kuhnia eupatorioides* L.—B. 2f / C.Hp / D.16.
var. *corymbulosa* T.&G.
- Liatris squarrosa* Willd.—B. 2f / C.Gst / D.17.
- L. cylindracea* Michx.—B. 2f / C.Gst / D.17.
- L. Bebbiana* Rydb.—B. 2f / C.Gst / D.17.
- L. spicata* (L.) Willd.—B. 2f / C.Gst / D.17.
- L. scariosa* Willd.—B. 2f / C.Gst / D.17.
f. *Benkei* Macbride
- Grindelia squarrosa* (Pursh) Dunal—B. 2f, ② / C.Hs / D.16.
var. *serrulata* (Rydb.) Steyermark
- Chrysopsis villosa* (Pursh) Nutt.—B. 2f / C.Hp / D.16.
- Solidago altissima* L.—B. 2f / C.Hsr / D.16.
- S. bicolor* L.—B. 2f / C.Hs / D.16.
- S. caesia* L.—B. 2f / C.Hpr / D.16.
- S. canadensis* L.—B. 2f / C.Hpr / D.16.
var. *Hageri* Fern.
- S. erecta* Pursh—B. 2f / C.Hs / D.16.
- S. Fisheri* Steele—B. 2f / C.Hp / D.16.
- S. Gillmani* (Gray) Steele—B. 2f / C.Hs / D.16.
- S. glaberrima* Martens—B. 2f / C.Hsr / D.16.
- S. hispida* Muhl.—B. 2f / C.Hs / D.16.
- S. juncea* Ait.—B. 2f / C.Hs / D.16.
- S. latifolia* L.—B. 2f / C.Hpr / D.16.

- S. longipetiolata* Mack. & Bush—B. 2f / C.Hs / D.16.
S. nemoralis Ait.—B. 2f / C.Hs / D.16.
S. ohioensis Riddell—B. 2f / C.Hs / D.16.
S. ovata Friesner—B. 2f / C.Hs / D.16.
S. patula Muhl.—B. 2f / C.Hs / D.16.
S. racemosa Greene—B. 2f / C.Hs / D.16.
S. Riddellii Frank—B. 2f / C.Hs / D.16.
S. rigida L.—B. 2f / C.Hs / D.16.
S. rigiduscula (T.&G.) Porter—B. 2f / C.Hs / D.16.
S. rugosa Miller—B. 2f / C.Hpr / D.16.
S. serotina Ait.—B. 2f / C.Hpr / D.16.
 var. *gigantea* (Ait.) Gray
S. Shortii T.&G.—B. 2f / C.Hp / D.16.
S. Deamii Fern.—B. 2f / C.Hs / D.16.
S. speciosa Nutt.—B. 2f / C.Hs / D.16.
S. sphacelata Raf.—B. 2f / C.Hs / D.16.
S. squarrosa Muhl.—B. 2f / C.Hs / D.16.
S. Buckleyi T.&G.—B. 2f / C.Hp / D.16.
S. suaveolens Schoepf.—B. 2f / C.Hp / D.16.
S. ulmifolia Muhl.—B. 2f / C.Hs / D.16.
S. uniligulata (DC.) Porter—B. 2f / C.Hs / D.16.
 var. *levipes* Fern.—var. *neglecta* (T.&G.) Fern.
S. hirtella (Greene) Bush—B. 2f / C.Hp / D.16.
S. media (Greene) Bush—B. 2f / C.Hpr / D.16.
S. perglabra Friesner—B. 2f / C.Hp / D.16.
S. remota (Greene) Friesner—B. 2f / C.Hp / D.16.
Brachychaeta sphacelata (Raf.) Britt.—B. 2f / C.Hsr / D.16.
Boltonia asteroides (L.) L'Her.—B. 2f / C.Hpr / D.16.
Aster macrophyllus L.—B. 2f / C.Hsr / D.16.
 var. *ianthinus* (Burgess) Fern.—var. *pinguifolius* Burgess—var. *velutinus* Burgess
A. furcatus Burgess—B. 2f / C.Hs / D.16.
A. azureus Lindl.—B. 2f / C.Hs / D.16.
A. Shortii Lindl.—B. 2f / C.Hs / D.16.
A. cordifolius L.—B. 2f / C.Hsr / D.16.
A. sagittifolius Wedemeyer—B. 2f / C.Hs / D.16.
A. Drummondii Lindl.—B. 2f / C.Hs / D.16.
A. undulatus L.—B. 2f / C.Hsr / D.16.
A. novae-angliae L.—B. 2f / C.Hpr / D.16.
 f. *roseus* (Desf.) Britt.
A. patens Ait.—B. 2f / C.Hpr / D.16.
A. oblongifolius Nutt.—B. 2f / C.Hsr / D.16.
 var. *rigidulus* Gray
A. prenanthoides Muhl.—B. 2f / C.Hpr / D.16.
A. laevis L.—B. 2f / C.Hs / D.16.
 var. *falcatus* Farw.
A. longifolius Lam.—B. 2f / C.Hpr / D.16.
A. lucidulus (Gray) Wieg.—B. 2f / C.Hpr / D.16.
 f. *firmus* (Nees) Deam

- A. praealtus* Poir.—B. 2f / C.Hsr / D.16.
 var. *angustior* Wieg.—var. *subasper* (Lindl.) Wieg.
A. junceus Ait.—B. 2f / C.Hp / D.16.
A. paniculatus Lam.—B. 2f / C.Hsr / D.16.
 var. *simplex* (Willd.) Burgess
A. interior Wieg.—B. 2f / C.Hsr / D.16.
A. linariifolius L.—B. 2f / C.Hpr / D.16.
A. puniceus L.—B. 2f / C.Hpr / D.16.
 var. *demissus* Lindl.—var. *compactus* Fern.
A. exiguus (Fern.) Rydb.—B. 2f / C.Hpr / D.16.
A. ericoides L.—B. 2f / C.Hsr / D.16.
A. sericeus Vent.—B. 2f / C.Hs / D.16.
A. pilosus Willd.—B. 2f / C.Hs / D.16.
 var. *platyphyllus* (T.&G.) Blake—var. *demotus* Blake—f. *pulchellus* Benke
A. missouriensis Britt.—B. 2f / C.Hsr / D.16.
 var. *thyrsoides* (Gray) Wieg.
A. umbellatus Mill.—B. 2f / C.Hpr / D.16.
A. ptarmicoides (Nees) T.&G.—B. 2f / C.Hsr / D.16.
A. lateriflorus (L.) Britt.—B. 2f / C.Hsr / D.16.
 var. *angustifolius* Wieg.
A. dumosus L.—B. 2f / C.Hs / D.16.
 var. *strictior* T.&G.
A. vimineus Lam. B. 2f / C.Hsr / D.16.
 var. *subdumosus* Wieg.
Erigeron canadensis L.—B. ① / C.Th / D.18.
E. pusillus Nutt.—B. ① / C.Th / D.18.
E. divaricatus Michx.—B. ① / C.Th / D.18.
E. pulchellus Michx.—B. 2f / C.Hsr / D.16.
E. philadelphicus L.—B. 2f / C.Hsr / D.16.
E. ramosus (Walt.) BSP.—B. ① / D.Th / D.18.
E. annuus (L.) Pers.—B. ① / C.Th / D.18.
Seriocarpus linifolius (L.) BSP.—B. 2f / C.Hs / D.16.
Pluchea viscida (Raf.) House—B. ① / C.Th / D.18.
Antennaria neglecta Greene—B. 2f / C.Ch / D.12.
A. neodioica Greene—B. 2f / C.Ch / D.12.
A. solitaria Rydb.—B. 2f / C.Ch / D.12.
A. Parlinii Fern.—B. 2f / C.Ch / D.12.
A. plantaginifolia (L.) Richards—B. 2f / C.Ch / D.12.
A. fallax Greene—B. 2f / C.Ch / D.12.
 var. *calophylla* (Greene) Fern.
A. munda Fern.—B. 2f / C.Ch / D.12.
Anaphalis margaritacea (L.) Benth. & Hook.—B. 2f / C.Hpr / D.16.
Gnaphalium obtusifolium L.—B. ① / C.Th / D.18.
G. Macounii Greene—B. 2f / C.Hpr / D.16.
G. uliginosum L.—B. ① / C. Th / D.18.
G. purpureum L.—B. ②, ① / C.Hsr / D.16.
**Inula Helenium* L.—B. 2f / C.Hs / D.16.
Polymnia canadensis L.—B. 2f / C.Hp / D.16.

- f. *radiata* (Gray) Fassett
P. Uvedalia L.—B. 2f / C.Hp / D.16.
Silphium terebinthinaceum Jacq.—B. 2f / C.Hs / D.16.
 var. *pinnatifidum* (Ell.) Gray
S. perfolium L.—B. 2f / C.Hs / D.16.
S. laciniatum L.—B. 2f / C.Hs / D.16.
S. trifoliatum L.—B. 2f / C.Hs / D.16.
S. integrifolium Michx.—B. 2f / C.Hpr / D.16.
Parthenium integrifolium Michx.—B. 2f / C.Hpr / D.16.
Iva ciliata Willd.—B. ① / C.Th / D.18.
I. xanthifolia Nutt.—B. ① / C.Th / D.18.
Ambrosia bidentata Michx.—B. ① / C.Th / D.18.
A. trifida L.—B. ① / C.Th / D.18.
A. artemisiaefolia var. *elatior* (L.) Desc.—B. ① / C.Th / D.18.
A. coronopifolia T.&G.—B. 2f / C.Hpr / D.16.
 **Xanthium spinosum* L.—B. ① / C.Th / D. 7, 18.
X. pennsylvanicum Wallr.—B. ① / C.Th / D.18.
X. italicum Mor.—B. ① / C.Th / D.18.
Heliopsis helianthoides (L.) Sweet.—B. 2f / C.Hs / D.16.
Eclipta alba (L.) Hassk.—B. ① / C.Th / D.18.
Rudbeckia hirta L.—B. ②, ① / C.Hs / D.16.
R. subtomentosa Pursh.—B. 2f / C.Hs / D.16.
R. laciniata L.—B. 2f / C.Hs / D.16.
R. triloba L.—B. 2f / C.Hs / D.16.
R. umbrosa Boynton & Beadle.—B. 2f / C.Hs / D.16.
R. palustris Eggert.—B. 2f / C.Hs / D.16.
R. fulgida Ait.—B. 2f / C.Hs / D.16.
R. Sullivantii Boynton & Beadle.—B. 2f / C.Hsr / D.16.
R. Deamii Blake.—B. 2f / C.Hs / D.16.
Brauneria purpurea (DC.) Britt.—B. 2f / C.Hs / D.16.
B. pallida (Nutt.) Britt.—B. 2f / C.Hs / D.16.
B. angustifolia (DC.) Heller.—B. 2f / C.Hs / D.16.
Lepachys pinnata (Vent.) T.&G.—B. 2f / C.Hs / D.16.
L. columnifera (Nutt.) Macbride.—B. 2f / C.Hs / D.16.
Helianthus angustifolius L.—B. 2f / C.Hpr / D.16.
H. rigidus (Cass.) Desf.—B. 2f / C.Grth / D.17.
H. annuus L.—B. ① / C.Th / D.18.
H. petiolaris Nutt.—B. ① / C.Th / D.18.
H. occidentalis Riddell.—B. 2f / C.Hsr / D.16.
H. microcephalus T.&G.—B. 2f / C.Hp / D.16.
H. divaricatus L.—B. 2f / C.Grth / D.17.
H. doronicoides Lam.—B. 2f / C.Hp / D.16.
H. hirsutus Raf.—B. 2f / C.Grth / D.17.
H. Maximiliana Schrad.—B. 2f / C.Hp / D.16.
H. grosse-serratus Martens.—B. 2f / C.Hp / D.16.
H. giganteus L.—B. 2f / C.Hp / D.16.
H. tuberosus L.—B. 2f / C.Gst / D.17.
H. decapetalus L.—B. 2f / C.Grth / D.17.

- Actinomeris alternifolia* (L.) DC.—B. 2f / C.Hp / D.16.
Verbesina helianthoides Michx.—B. 2f / C.Hp / D.16.
Coreopsis lanceolata L.—B. 2f / C.Hs / D.16.
 var. *villosa* Michx.
C. palmata Nutt.—B. 2f / C.Hs / D.16.
 **C. grandiflora* Hogg.—B. 2f / C.Hs / D.16.
C. tripleris L.—B. 2f / C.Hs / D.16.
 var. *Deamii* Standley—var. *intercedens* Standley
Bidens cernua L.—B. ① / C.Th / D.18.
B. comosa (Gray) Wieg.—B. ① / C.Th / D.18.
B. connata Muhl.—B. ① / C.Th / D.18.
 var. *petiolata* (Nutt.) Farw.
B. bipinnata L.—B. ① / C.Th / D.18.
B. discoidea (T.&G.) Britt.—B. ① / C.Th / D.18.
B. coronata (L.) Britt.—B. ① / C.Th / D.18.
B. aristosa (Michx.) Britt.—B. ① / C.Th / D.18.
 var. *Fritcheyi* Fern.—var. *mulica* (Gray) Gatlinger
B. frondosa L.—B. ① / C.Th / D.18.
B. vulgata Greene—B. ① / C.Th / D.18.
B. polylepis var. *retrorsa* Sherff—B. ① / C.Th / D.18.
Megalodonta Beckii (Torr.) Greene—B. 2f / C.HH / D.19.
 **Galinsoga ciliata* (Raf.) Blake—B. ① / C.Th / D.18.
 **Madia capitata* Nutt.—B. ① / C.Th / D.18.
Hymenopappus carolinensis (Lam.) Porter—B. ② / C.Hs / D.16.
Helenium tenuifolium Nutt.—B. ① / C.Th / D.18.
H. autumnale L.—B. 2f / C.Hs / D.16.
H. nudiflorum Nutt.—B. 2f / C.Hs / D.16.
Dyssoidia papposa (Vent.) Hitchc.—B. ① / C.Th / D.18.
 **Anthemis Cotula* L.—B. ① / C.Th / D.18.
 **A. arvensis* L.—B. ① / C.Th / D.18.
 **A. nobilis* L.—B. 2f / C.Ch / D.12.
Achillea Millefolium L.—B. 2f / C.Hsr / D.16.
 **Matricaria matricarioides* (Less.) Porter—B. ① / C.Th / D.18.
 **Chrysanthemum Leucanthemum* var. *pinnatifidum* Lecoq & Lamotte—B. 2f / C.Hs / D.16.
 **C. Balsamita* var. *tanacetoides* Boiss.—B. 2f / C.Hs / D.16.
 **Tanacetum vulgare* L.—B. 2f / C.Hs / D.16.
 var. *crispum* DC.
 **Artemisia Absinthium* L.—B. 2f / C.Ch / D.9.
A. biennis Willd.—B. ②, ① / C.Hs / D.16.
 **A. annua* L.—B. ① / C.Th / D.18.
A. caudata Michx.—B. 2f / C.Hs / D.16.
A. gnaphalodes Nutt.—B. 2f / C.Hs / D.16.
Erechtites hieracifolia (L.) Raf.—B. ① / C.Th / D.18.
Cacalia suaveolens L.—B. 2f / C.Hs / D.16.
C. atriplicifolia L.—B. 2f / C.Hs / D.16.
C. reniformis Muhl.—B. 2f / C.Hs / D.16.
C. tuberosa Nutt.—B. 2f / C.Gst / D.17.
 **Senecio vulgaris* L.—B. ① / C.Th / D.18.

- S. glabellus* Poir.—B.① / C.Th / D.18.
S. plattensis Nutt.—B.2f / C.Hsr / D.16.
S. obovatus Muhl.—B.2f / C.Hsr / D.16.
S. aureus L.—B.2f / C.Hs / D.16.
 var. *gracilis* (Pursh) Britt.
S. pauperculus var. *Balsamitae* (Muhl.) Fern.—B.2f / C.Hs / D.16.
**Arctium minus* (Hill) Bernh.—B.② / C.Hs / D.16.
**Carduus nutans* L.—B.② / C.Hs / D.16.
**Cirsium lanceolatum* (L.) Hill—B.② / C.Hs / D. 7, 16.
C. Pitcheri (Torr.) T.&G.—B.② / C.Hs / D. 7, 16.
**C. arvense* (L.) Scop.—B.2f / C.Gr / D. 7, 17.
 var. *mile* Wimm. & Grab.—var. *integrifolium* Wimm. & Grab.
C. Hillii (Canby) Fern.—B.2f / C.Hs / D. 7, 16.
C. muticum Michx.—B.② / C.Hs / D. 7, 16.
C. virginianum (L.) Michx.—B.② / C.Hs / D. 7, 16.
C. discolor (Muhl.) Spreng.—B.2f / C.Hs / D. 7, 16.
C. altissimum (L.) Spreng.—B.② / C.Hs / D. 7, 16.
**Onopordum Acanthium* L.—B.② / C.Hs / D. 7, 16.
**Cichorium Intybus* L.—B.2f / C.Hs / D.16.
Serinia oppositifolia (Raf.) Ktze.—B.① / C.Th / D.18.
Krigia Dandelion (L.) Nutt.—B.2f / C.Hrr / D.14.
K. virginica (L.) Willd.—B.① / C.Th / D.18.
K. biflora (Walt.) Blake—B.2f / C.Hs / D.16.
**Tragopogon porrifolius* L.—B.2f, ② / C.Hs / D.16.
**T. pratensis* L.—B.2f, ② / C.Hs / D.16.
**Taraxacum palustre* var. *vulgare* (Lam.) Fern.—B.2f / C.Hr / D.14.
**T. laevigatum* (Willd.) DC.—B.2f / C.Hr / D.14.
**Sonchus arvensis* L.—B.2f / C.Hsr / D. 7, 16.
 var. *glabrescens* Guenth. Grab. & Wimm.
**S. oleraceus* L.—B.① / C. Th / D.18.
**S. asper* (L.) Hill—B.① / C.Th / D. 7, 18.
**Lactuca Scariola* L.—B.②, ① / C.Hs / D.16.
 var. *integrata* Gren. & Godr.
L. campestris Greene—B.② / C.Hs / D.16.
**L. saligna* L.—B.② / C.Hs / D.16.
L. canadensis var. *typica* Wieg.—B.②, ① / C.Hs / D.16.
 var. *latifolia* O. Kuntze—var. *integrifolia* (Bigel.) Gray
 f. *angustata* Wieg.—var. *obovata* Wieg.
L. villosa Jacq.—B.① / C.Th / D.18.
L. floridana (L.) Gaertn.—B.① / C.Th / D.18.
L. spicata (Lam.) Hitchc.—B.②, ① / C.Hs / D.16.
 var. *integrifolia* (Gray) Britt.
Pyrhopappus carolinianus (Walt.) DC. —B.②, ① / C.Hs / D.16.
**Crepis capillaris* (L.) Wallr.—B.① / C.Th / D.18.
**C. pulchra* L.—B.① / C.Th / D.18.
Prenanthes altissima L.—B.2f / C.Hsr / D.16.
 f. *cinnamomea* Fern.
P. trifoliata (Cass.) Fern.—B.2f / C.Hsr / D.16.
P. alba L.—B.2f / C.Hsr / D.16.

- P. racemosa* Michx.—B. 2f / C.Hs / D.16.
P. aspera Michx.—B. 2f / C.Hs / D.16.
P. crepidinea Michx.—B. 2f / C.Hs / D.16.
**Hieracium aurantiacum* L.—B. 2f / C.Hsr / D.16.
H. canadense Michx.—B. 2f / C.Hp / D.16.
H. Gronovii L.—B. 2f / C.Hs / D.16.
H. longipilum Torr.—B. 2f / C.Hs / D. 7, 16.
H. venosum L.—B. 2f / C.Hs / D.16.
H. paniculatum L.—B. 2f / C.Hp / D.16.
H. scabrum Michx.—B. 2f / C.Hp / D.16.

TABLE 5

Summary of introduced species including the total number occurring in the respective families, with their distribution according to duration and life-form.

Family	no. sp.	Duration					Life-form				
		h	h	2f	②	①	Ph	Ch	H	Cr	Th
Potamogetonaceae	1			1						1	
Gramineae	42			23		19			19	4	19
Liliaceae	9			9				1		8	
Iridaceae	1			1						1	
Orchidaceae	1			1						1	
Salicaceae	3	3					3				
Moraceae	4	2				2	2				2
Urticaceae	1			1					1		
Polygonaceae	9			3		6			3		6
Chenopodiaceae	7			1		6			1		6
Amaranthaceae	7					7					7
Aizoaceae	1					1					1
Portulacaceae	1					1					1
Caryophyllaceae	15			4	1	10		1	4		10
Ranunculaceae	5			3		2			3		2
Berberidaceae	3		3				3				
Papaveraceae	1				1				1		
Cruciferae	27			7	7	13			12	2	13
Crassulaceae	1			1				1			
Rosaceae	5	1	2	2			3		2		
Leguminosae	18			6	3	9			8	1	9
Geraniaceae	2					2					2
Simarubaceae	1	1					1				
Euphorbiaceae	3			2		1			2		1
Hippocastanaceae	1	1					1				
Sapindaceae	1	1					1				
Rhamnaceae	1		1				1				

Family	no. sp.	Duration					Life-form				
		h	h	2f	②	①	Ph	Ch	H	Cr	Th
Malvaceae	6			1	2	3			3		3
Hypericaceae	1			1					1		
Violaceae	2				2				2		
Lythraceae	1			1					1		
Umbelliferae	6			2	2	2			4		2
Primulaceae	2			1		1		1			1
Apocynaceae	1			1				1			
Convolvulaceae	5			2		3			1	1	3
Polemoniaceae	1				1				1		
Boraginaceae	6			2	2	2			4		2
Labiatae	14			10	1	3			11		3
Solanaceae	4		1			3	1				3
Scrophulariaceae	12	1		4	3	4	1	2	5		4
Bignoniaceae	2	1	1				2				
Plantaginaceae	1			1					1		
Rubiaceae	1					1					1
Caprifoliaceae	1		1				1				
Valerianaceae	1					1					1
Dipsacaceae	1				1				1		
Compositae	33			15	6	12		2	18	1	12

TABLE 6

Summary of the distribution of the native and naturalized species.

			Duration					Life-form				
	Fam	Spp.	h	h	2f	②	①	Ph	Ch	H	Cr	Th
Native & Natr.	133	2109	142	181	1340	94	352	301	41	1033	380	352
Naturalized	47	272	11	9	106	32	114	20	9	109	20	114
Native	87	1843	32	172	1234	62	238	281	32	924	360	238

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EXPLANATION OF PLATES

Plates 1-5, drawn by Theodor Holm and originally published in connection with his contribution "Hibernation and rejuvenation, exemplified by North American Herbs" (*Amer. Mid. Nat.* 9:439-512), are here reproduced to illustrate the principal methods by which the perennial habit is effected. The organs concerned in these six types of hibernation and rejuvenation are: (1) the primary root (Figs. 1-9), (2) the secondary root-system (Figs. 16-18), (3) the hypocotyl (Figs. 19-27), (4) the cotyledonary buds (Figs. 29-32), (5) the plumule (Figs. 33-35), (6) buds upon the lateral roots (Pl. 6, Fig. 1). Several specimens shown are not found in Indiana.

Plates 6 and 7, photographic reproductions of several specimens in the Nieuwland Herbarium, show some mature perennating organs.

Symbols used in plates 1-5:

B.—bud	R.—primary root
Cot.—cotyledon	r.—secondary root
Hyp.—hypocotyl	S.—seed enclosing cotyledon (Pl. 1, Fig. 7); rhizome (Pl. 5, Fig. 45)
L.—leaf	St.—stem
l.—scale-leaf	

PLATE I

FIGURES

1. *Erigenia bulbosa* (Michx.) Nutt.—Plant in third year, showing globose primary root with four slender branches, and green leaf with a small, scale-like leaf at its base. Nat. size. This represents the simplest type of perennial herb. Hibernating stage shows only the root and a bud.
2. *Claytonia virginica* L.—Germination. Nat. size. The long, filiform apex of the main root dies off during the first season, while the basal portion persists and increases gradually in thickness, soon becoming globular. The first hibernation is marked by a tuberous root and a bud.
3. *Calandrinia pygmaea* Gray—Germination. Enlarged. (Not found in Indiana.)
4. *Panax quinquefolium* L.—Hibernation. Nat. size. Short vertical rhizome with scale-leaves exactly opposite.
5. Same species. Rejuvenation. Nat. size.
6. Same species. Part of rhizome of mature specimen, showing subterranean internodes, the base of primary root, and the base of aerial stem. x 2.
7. *Panax trifolium* L.—Germination. x 2.
8. Same species. Rhizome and root of a mature specimen. Nat. size. Short vertical rhizome with leaves exactly opposite.
9. *Galactia volubilis* var. *mississippiensis* Vail.—Rejuvenation. x 2/3.

PLATE 2

10. *Oxypolis rigidior* (L.) Raf.—Germination. Nat. size.
11. Same species. Rejuvenation, second year.
12. Same species. Rejuvenation, third year.
13. Same species. Hibernation. Mature specimen.
14. *Cicuta maculata* L.—Rejuvenation. Rhizome of a mature specimen. Small but in axil of basal-leaves winters over. Nat. size.
15. Same species. Bud detached from rhizome of old specimen to produce a new individual. x 2/3.
16. *Ranunculus abortivus* L.—Germination. x 3.
17. Same species. Older seedling. Rejuvenation depends upon buds in axils of basal leaves. Short rhizome. Perennial, not biennial. x 3.

PLATE 3

18. Same species. Older seedling, x 3.
19. *Sanguinaria canadensis* L.—Germination Nat. size.
20. Same species. Rejuvenation. A plant in its second year. Nat. size. (See Fig. 41)
21. *Collinsonia canadensis* L.—A seedling at the autumnal stage. Nat. size. (Mature tubers vary in size. Secondary roots push out from lower face and sides of tuber.)
22. *Arisaema triphyllum* (L.) Schott—Germination. x 4.
23. Same species. A seedling at end of first season. x 4.
24. Same species. Rejuvenation. A specimen in its third year, showing tuberous rhizome with four secondary roots, three membranaceous, scale-like leaves, and one aerial green leaf. x 4.
25. *Dioscorea paniculata* Michx.—Plant in its second year. Nat. size.
26. Same species. Seed has been removed to show the cotyledon. Nat. size.
27. Same species. Schematic drawing of a seedling at close of first season. Enlarged.
B1 develops as a small tuber which remains subterranean, forming a lateral branch or remaining dormant; B2 continues the horizontal growth of the rhizome; B3 develops into aerial shoot.

PLATE 4

28. *Cimicifuga racemosa* (L.) Nutt.—First hibernation, showing upper part of hypocotyl, secondary roots and an apical bud covered by two small scale-leaves. x 2.
29. *Cunila origanoides* (L.) Britt.—Hibernation. A tuberous, subterranean shoot has developed from the axil of one of the cotyledons. x 5. Rejuvenation by means of the lateral shoots with the basal internodes fleshy, covered with scale-leaves.

30. *Hypericum virginicum* L.—Hibernation. Tuberous cotyledonary shoots have been developed. Nat. size.
31. Same species. Rejuvenation. A branch of the rhizome developing into an aerial shoot; the secondary roots proceed from the axils of the scale-like leaves, and a small stolon is about to develop. x 2/3. (Aerial shoots die off in the fall. Tuberous stolons continue their growth, branching and producing aerial shoots.)
32. *Baptisia tinctoria* R. Br.—Rejuvenation. Plant in its second year. Nat. size. (Mature plant is characterized by a pseudo-rhizome. Small tubular membranous leaves subtend the perennating buds.)
33. *Dentaria laciniata* Muhl.—Germination. x 3. (Mature rhizome is a horizontal chain of long tubers.)
34. *Dicentra Cucullaria* (L.) Bernh.—Rejuvenation. A young plant developed from a bud in the axil of a fleshy, scale-like leaf of the rhizome. x 3. (This plant shows a very peculiar structure of the rhizome. It is short, densely covered with tuber-like leaves, supporting and partly enclosing axillary buds, able to produce new individuals. It is intermediate between a bulb and rhizome.)
34. *Viola papilionacea* Pursh—Rejuvenation. The rhizome of a plant in its second year. x 2. (Mature rhizome is horizontal, a combination of bulb and rhizome.)
36. *Oxalis violacea* L.—Rejuvenation. A bulb with two young stolons and a large storage-root. Nat. size.

PLATE 5

37. *Podophyllum peltatum* L.—Rejuvenation. Apex of the rhizome of a mature specimen, showing the scale-leaves surrounding the flower-bearing stem. x 2/3.
38. Same species. Apex of a mature specimen seen from below; the scale-leaves have been removed to show the buds; the largest bud at the base of the stem is terminal, but remains dormant. One of the two swollen buds will continue the growth of the rhizome. x 2/3.
39. Same species. Rejuvenation. One of the two green leaves. Enlarged.
40. Same species. Same leaf with the base laid open to show the other green leaf. Enlarged.
41. *Sanguinaria canadensis* L.—Rejuvenation. x 2/3. (See Figs. 19, 20)
42. *Dentaria diphylla* Michx.—Rejuvenation. Rhizome with a green leaf subtending a branch. x 2/3. (The rhizome represents a transition between a bulb and a rhizome.)
43. *Lithophragma tenella* Nutt.—One of the bulbs from the base of the stem. Enlarged. (Not found in Indiana.)
44. Same species. Same bulb, longitudinal section.
45. *Platanthera clavellata* Michx.—Hibernation. x 2/3. (Not found in Indiana.)
46. *Hypericum mutilum* L.—Base of a mature specimen with several serial shoots to hibernation. Nat. size. (Pseudo-rhizome in its simplest form.)

PLATE 6

1. *Rhexia virginica* L.—Tuberous root with shoots and buds. Development of root-shoots is the only means of vegetative reproduction. Specimen collected by J. A. Nieuwland in Stark Co., 7-23-30.
2. *Scutellaria parvula* Michx.—Tuberiferous stolon. Rejuvenation depends upon formation of an aerial shoot from the apex of the stolon. Specimen collected by Th. Just in St. Joseph Co., 6-5-30.

PLATE 7

3. *Polygala polygama* Walt.—Perennial, not biennial. Aerial shoots die off at close of season but the basal internodes remain active with their axillary buds. Typical pseudo-rhizome. Specimen collected by Th. Just in St. Joseph Co., 6-29-30.
4. *Hydrophyllum canadense* L.—Horizontal rhizome bears several fleshy scales preceding the aerial leaves, thus representing a transition between bulb and rhizome. Specimen collected by J. A. Nieuwland in St. Joseph Co., 5-26-10.

PLATE I

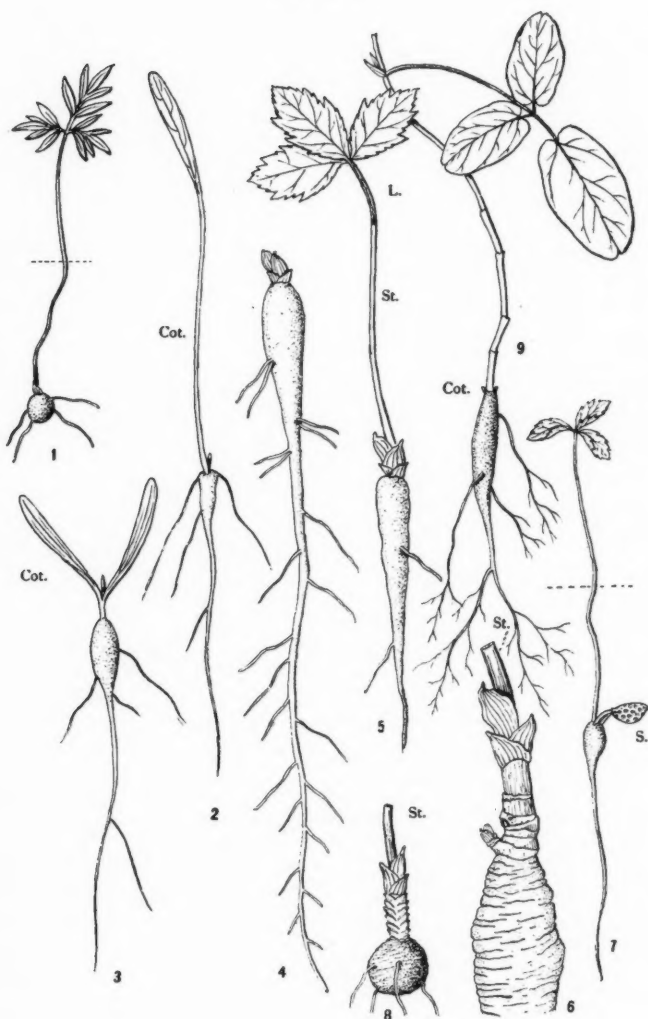


PLATE 2

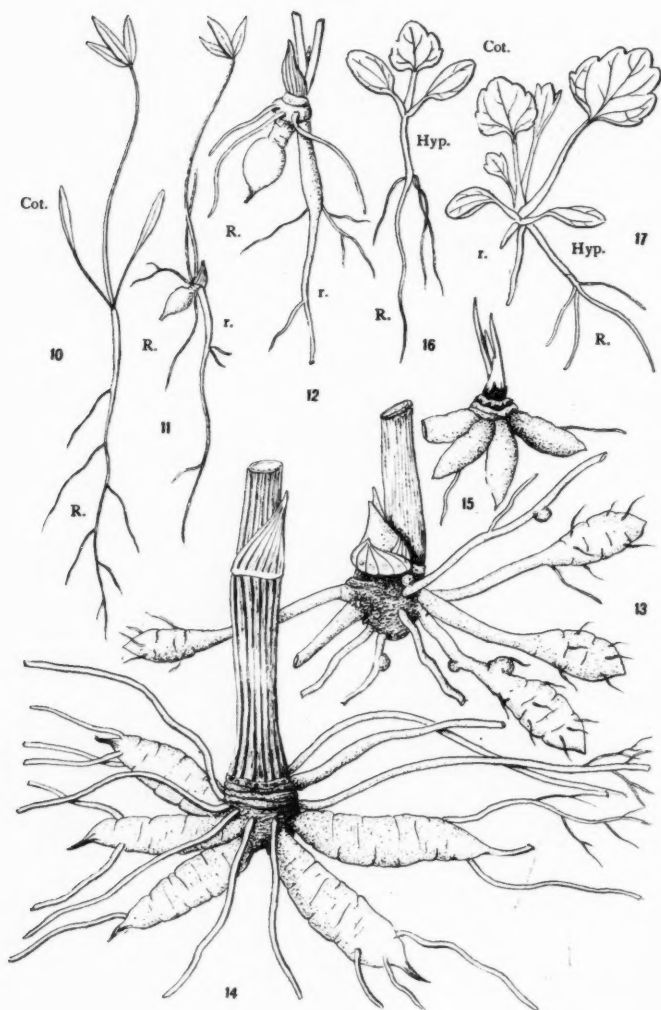


PLATE 3

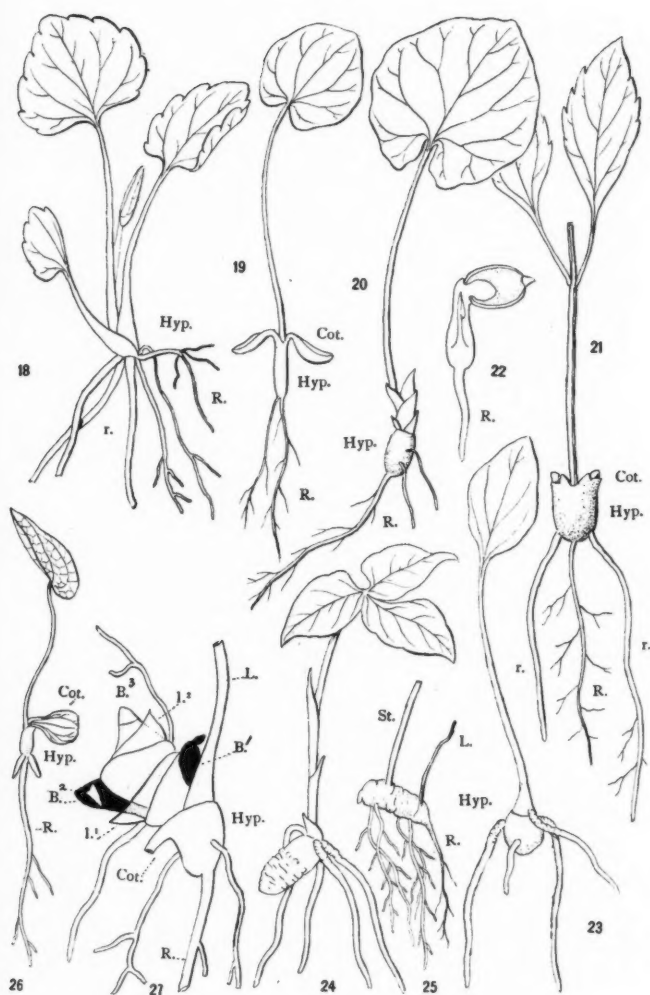


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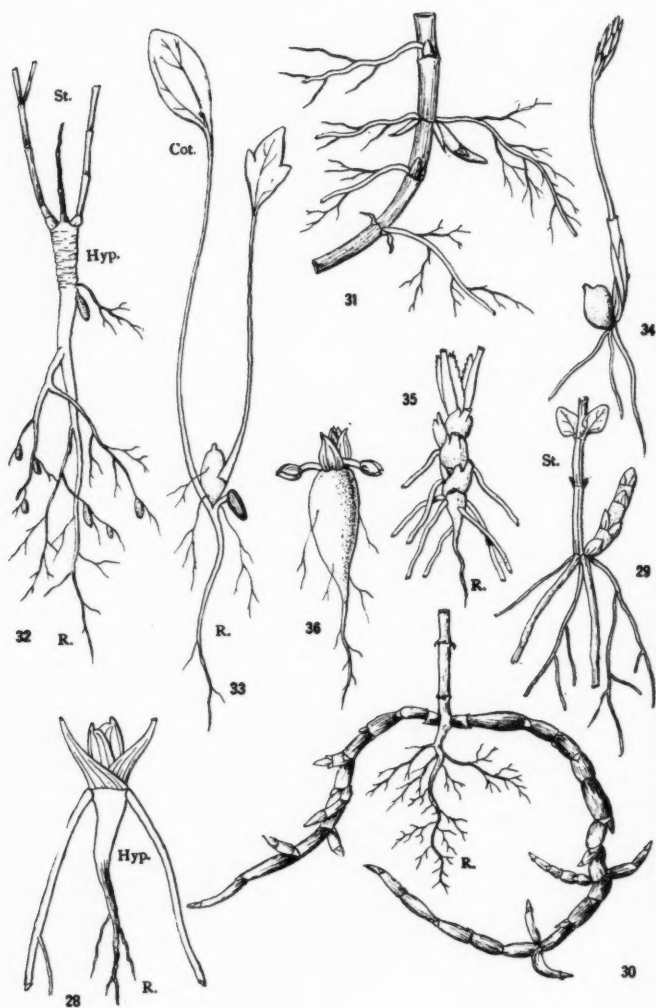


PLATE 5

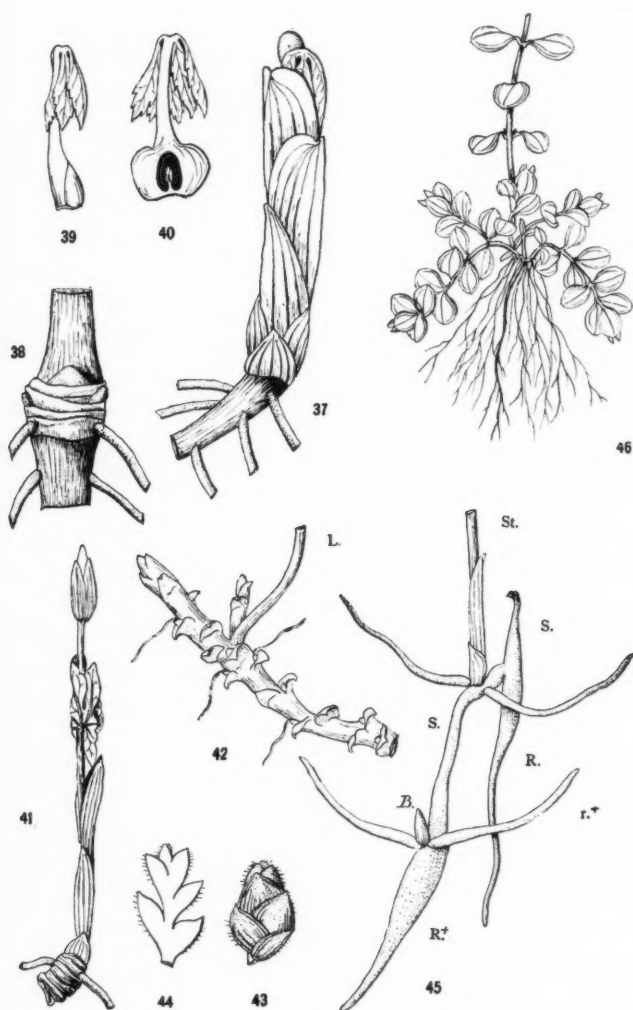


PLATE 6



PLATE 7



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LIFE-FORMS OF FLOWERING PLANTS, IND.

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The Lemnaceae of Indiana

Lawrence E. Hicks

The *Lemnaceae* represent a group of floating aquatic plants of considerable economic and biological importance and of unique botanical interest. Of about 26 species known in the world, 13 are known from the United States and 10 from Indiana. The family includes the smallest flowering vascular plants in the world and the flowers themselves are among the most minute.

This group demonstrates a highly efficient method of vegetative reproduction. These floating plants produce marked ecological effects upon the habitats in which they live and provide homes and the chief or sole food resources for many vertebrate and invertebrate animal organisms. Duckweeds are unique and valuable subjects for physiological experiments concerning plant growth, the study of inheritance, and the paths of evolutionary development.

The family is considered one of the most difficult because of (1) the small size of the plants, (2) the small size and rarity of the flowers and fruit, (3) the difficulty of preserving in pressed specimens characters available in the field, (4) the divergent appearance of plants of the same species and heredity when produced under different plant growth conditions, (5) the seasonal disparity between vegetative and flowering plants of the summer and the hibernacula or modified resting plants of winter, (6) the perpetuation locally by vegetative division of clones of new mutant forms with marked heritable variations, (7) the lack of adequate descriptions and illustrations of these variations, and (8) the general misconceptions as to the plant morphology and evolutionary developments.

Because of the complexities of the group and the unavailability of accurate information pertaining to it, considerable data are included in this treatment to cover the features essential for an understanding of the family.

A duckweed plant actually consists of a flattened or attenuated stem with one node and parts of the two adjacent internodes fused with any rudiments of the original leaves or petioles. No botanical term now available is correctly applicable to this structure, hence we can refer to it simply as a "shoot" or "plant."

Due to vegetative budding from the one or two reproductive pouches borne by each plant and delay in the abscission of the connecting internode, two or more plants are commonly joined together, but each should be considered as a separate individual. From the node of each plant radiates: (1) the flattened plant body with the nerves or vascular bundles (if developed), (2) the reproductive pouch or pouches through which the new plants, the flowers (if occurring), and the various resting forms grow by budding from the node, and (3) the root or roots (if present).

The internode includes that portion of the stem by which the flowers, fruit, resting forms, or young plants are attached for a time to the node of the parent plant. The internode is usually very short so that joined plants appear to be sessile but in some species it may be greatly elongated as in normal submerged forms of *Lemna trisulca* and in some very rapidly growing forms of *Spirodela polyrhiza*.

Duckweeds, although minute, because of their tremendous numbers and remarkable powers of reproduction, have pronounced influences upon aquatic habitats and constitute a valuable food supply for many animal organisms. A single individual duckweed can multiply to several millions in a single season. Compact floating mats of duckweeds such as are general in late summer, contain from 100,000 to 200,000 plants per square yard of water surface (genus *Spirodela*), 300,000 to 800,000 per square yard (genus *Lemna*), and 1,000,000 to 2,000,000 per square yard (genus *Wolffia*).

Several species of fish, more than 20 species of ducks, and many other water birds in addition to many insects and spiders are known to feed extensively upon duckweeds. Pond snails (*Physa*) have been observed to engulf 10 to 15 *Wolffia* plants within a few minutes' time.

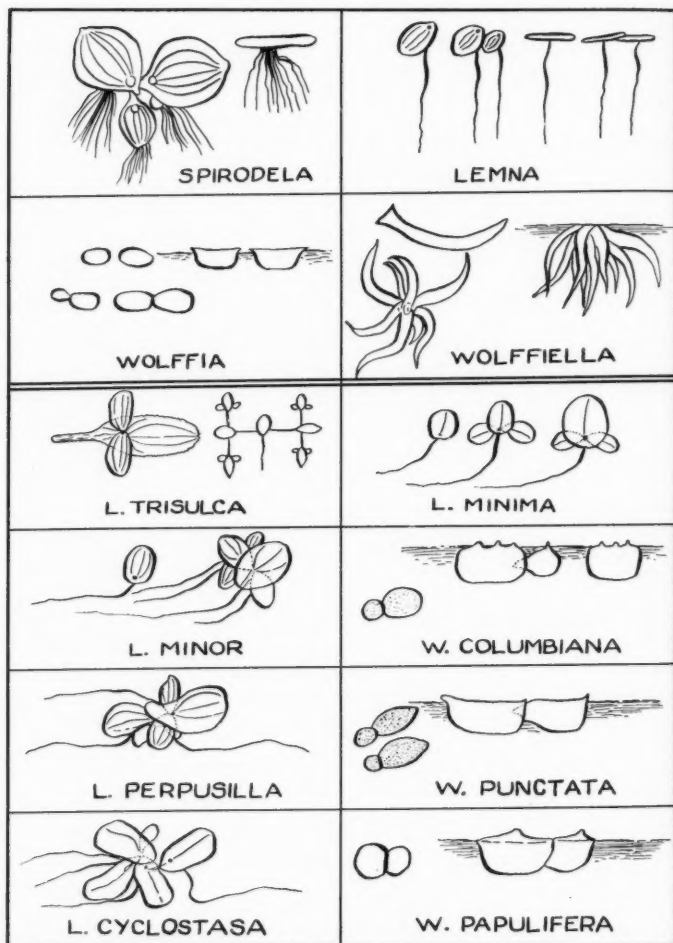
For satisfactory growth duckweeds require anchorage. Their population density usually increases as the water movement decreases. A permanent water supply is indispensable as none of the species can survive in the desiccated basins of temporary pools. Freedom from floods and wind and wave action is important and the necessary anchorage may be supplied by many species of emergent woody or herbaceous aquatic plants or by other floating or bottom attached forms such as *Ceratophyllum demersum*. Other important growth factors include the water temperature, degree of shading, bottom type, chemical and organic content (including acidity and alkalinity) of the water, competition with other aquatic plants and depredation by animals.

Duckweeds may be introduced to new water areas by transfer along regular watercourses, by floods, aquatic birds, fish, mammals, or man. Man unknowingly transports them along with fish released for stocking or when attempting to establish other aquatic plants. In many marshes they are intentionally introduced to provide food for waterfowl.

Key to Location of Duckweed Collections from Indiana:*

B	Butler University	IU	Indiana University
Ba	Edna Banta, Bloomington, Ind.	K	Ralph M. Kriebel, Bedford, Ind.
D	Deam Herbarium	L	Marcus Ward Lyon Jr., South Bend, Ind.
DP	DePauw University	MK	Madge McKee, Goodland, Indiana
Hi	Lawrence E. Hicks, Columbus, Ohio	N	U. S. National Herbarium
		P	Purdue University

* Note: The distribution maps of duckweeds in Indiana and most of the records recorded on them, were compiled by Mr. Charles C. Deam of Bluffton, Indiana in connection with his forthcoming book on "The Flora of Indiana."



KEY

Plants with roots and two reproductive pouches from each node.

Each plant of a group with several roots growing out in a fascicle from the node; plants of the Indiana representative usually reddish below and with a red eye spot (the node) above; dorsal surface of living specimens a glossy green ----- *Spirodela*.

Each plant of a group with only one root ----- *Lemna*.

Plants without roots and with only one reproductive pouch from each node ---- *Wolffia*.

Plants thick and globular.

Plants thin and straplike, usually submerged and attached in groups shaped like rimless wheels ----- *Wolffia*.

SPIRODELA Schleid.

1. *Spirodela polyrhiza* (L.) Schleid. Greater Duckweed. Map 1.—Plants solitary or held in groups of 2-5 by the short persistent internodes, disk-shaped, tending to be pinched at the nodal end and usually decidedly unsymmetrical in relation to the long axis. Sun plants glossy yellowish green with prominent red eye spot at the node. The 5-15 nerves have one vascular bundle each and extend palmately from the node. The basal portions of the nodes are usually distinctly red pigmented. Shade plants are larger, thinner, more bluish green, less glossy and show little or no red pigment above. Lower surface of both forms usually deep purplish red.

The plants range in size from 2.2-6.5 mm wide by 2.4-9.5 mm long, averaging about 3.5 mm by 6 mm. Each plant bears 3-16 roots, commonly 4-9, with an average length of 7-18 mm, but extremes of 1-31 mm are sometimes noted. The roots have one vascular bundle and a thin pointed root cap.

Vegetative reproduction and the production of flowers or resting plants is by means of buds growing outward at right angles from the node through the two reproductive pouches. Overwintering takes place by hibernacula which develop in the fall of the year or freely at any other time when growth conditions are below optimum. These hibernacula are small compact rootless plants, circular to oval in shape, dark green and convex above, intensely red pigmented and flat below. These bodies have a density greater than one and a minimum of intercellular air spaces. They usually drop from the parent plant by abscission soon after formation, fall to the bottom, and rise to the surface in the spring due to an increase in buoyancy following growth and gas formation at the increased water temperatures. Immense piles of hibernacula are commonly washed up on beaches in both spring and autumn.

Flowers are very rarely produced, even under experimental conditions, and have been recorded by scarcely more than a dozen observers in the last two centuries. They consist of a simple spadix with one pistillate and two staminate flowers extending from the node through the reproductive pouches, the spathe opening sacklike at the upper end. The pistil is flask-shaped with one or two ovules. The fruit is a rounded utricle with winged margins.

MAP No. 2
Lemna trisulca L.

transversely. The fruit is ovoid, more or less ribbed and the endosperm has 1-3 layers.

KEY

Plants feather-shaped with the basal portions of the long internodes narrowed into petiolelike stems, usually submerged ----- 1. *L. trisulca*.

Plants oval to oblong, without petiolelike stems, connected plants appearing sessile, usually floating.

Plants symmetrical or nearly so.

Plants deep green, thickish convex on both surfaces, margins thick, obscurely 3-veined, cavernous throughout, appearing medium thick when pressed; sometimes reddish or purplish, especially below ----- 2. *L. minor*.

Plants usually pale green, lower surface nearly flat, margins thin, obscurely 1-veined, cavernous in the middle portions only; membranous when pressed ----- 3. *L. minima*.

Plants unsymmetrical.

Body of plant obliquely obovoid, medium thick, usually deep green with some reddish purple, distinctly 3-veined, root sheath with lateral wing appendages, cavernous throughout ----- 4. *L. perpusilla*.

Body of plant long-oblong, thin, pale green, obscurely 1-veined; root sheath unappendaged, cavernous in the middle portions only ----- 5. *L. cyclostasa*.

1. *Lemna trisulca* L. Submerged Duckweed. Map 2.—Plants dark green, feather-shaped, with the basal portion of the long internodes narrowed into petiolelike stems, remaining connected after formation so that many generations are commonly attached in a dense tangled mass. Plants more or less falcate and unsymmetrical, faintly 3-veined and without papules. Terminal margins thin, serrate and commonly fluted with an acute apex. Base hastate and attenuated into a flat stipe 0.51-1 mm wide and 4-16 mm long. The remainder of the enlarged flattened portion of the plant is 1.4-3 mm wide by 4-10 mm long. The stomata are not developed.

Roots frequently absent from a majority of the plants, varying greatly in length and abundance, ranging from 1-34 mm in length, thin, tapering, and somewhat coiled. Root sheath with lateral longitudinal wing appendages which disappear early. Root cap short-pointed, long, and cylindrical.

Reproduction vegetative by budding from paired reproductive pouches at each node. The flowering plants are commonly only 2 mm wide by 3 mm long and are usually united in groups of 2-4. These flowering plants are produced by growth and abscission from the submerged vegetative form. They are much smaller and are convexly curved, have very short internodes, are light green in color, decidedly cavernous and hence buoyant, and develop stomata but fail to produce roots.

The flowers develop from the node, growing out through the paired reproductive pouches of the plant body, and are monoecious, consisting of two stamens with two pollen sacks in each anther and a single flask-shaped pistil, enclosed in a spathe. Fruit a symmetrical utricle. Seeds deeply 12-15-

ribbed showing numerous transverse striations. The flowers are not rare, sometimes being produced in quantities and a few being produced in some habitats nearly every year.

Found commonly in ponds, shallow lakes, sloughs, and bogs, often growing where well shaded or beneath floating species, seeming to prefer cold water and often a hardy perennial. No true hibernacula are formed by this species, it being carried over the winter by the percentage of plants which remain alive in a small compact form of the usual submerged plants. This species has a pH tolerance range of about 4.7-7.5, but is more frequently encountered in ranges of 5.1-6.9.

Southern B.C. to Sask., Ont., N.S., Fla., Tex., and Calif.; also in parts of Eu., Asia, Africa, and Australia.

2. *Lemna minor* L. Lesser Duckweed. Map 3.—Plants obovate or round to elliptic, symmetrical or, in fruit slightly unsymmetrical; thickish convex on both surfaces, appearing medium thick when pressed; obscurely 3-veined, rarely 4-5-veined; stomata developed throughout; midnerve most prominent and sometimes with a row of papules; cavernous throughout; plants single, or 2-8 attached by the persistent internodes, commonly 2-4; plants 1.5-3 mm wide by 2-4 mm long; upper surface a dark green or a lighter green when in the flowering stage and very smooth and glistening so that water rolls from it in the spheroidal form as from a greased surface without wetting the plant; lower surface sometimes tinged with red or purple. A variety (*purpurea*) is purplish or brownish on both surfaces, but more intensely so below. This variety is especially marked in the winter forms.

Roots, one from each plant, growing downward from the node, unsheathed, 2-73 mm long but commonly 5-40 mm, root cap comparatively short and obtuse or subtruncate.

Reproduction is vegetative by rapid budding from the paired reproductive pouches placed on either side of each node. Flowers are rather easily produced experimentally and sometimes are found abundantly in nature, and at least a few are produced nearly every season. The flowers have a flask-shaped pistil whose stigma barely extends beyond the tip of the spathe. The two stamens each have paired pollen sacks. The fruit is a symmetrical, subtruncate, wingless utricle which projects about a third beyond the edge of the plant. The seeds are oblong-obovate with a prominent protruding hilum and are deeply and unevenly 12-15-ribbed. The seed coats are thick with many transverse striations.

The hibernacula or winter forms are oval, dark green, usually rootless, thick and with compact tissues, and noncavernous, with a density greater than that of the medium.

General and often extremely abundant in lakes, ponds, marshes, bogs, ditches, and other stagnant water, even developing in sluggish streams; sometimes covering many acres of water surface. The most abundant and most widely distributed species in much of the United States but it ranks second to *Spirodela polyrrhiza* in Indiana. *Lemna minor* has a pH tolerance range

of 4.4-7.9 but is usually found between 5.1-6.7. This duckweed has a wider pH tolerance range than all of the other Indiana species combined.

Known from at least 30 scattered Indiana counties, but more general along the Wabash drainage and in the northern third of the state.

Found in all of continental North America except in the extreme north and also found in Europe, Asia, Africa, and Australia.

3. *Lemna minima* Phillipi. Least Duckweed. Map 4.—Plants oblong to elliptic, symmetrical or with the abscission scar a little to one side of the median line; solitary or persisting in groups of 2-4, more commonly in 2's; obscurely 1-veined with a row of minute papules along the vein, or veinless; cavernous in the middle portion only, the entire periphery of the plant being thin margined; strikingly convex on the upper surface, flat or slightly convex on the lower surface; yellowish or pale green in color; 1.1 mm wide by 1.7 mm long, but vigorous growth forms may be somewhat larger, thinner and more green. All forms membranous when pressed.

Roots, one from each plant, long, thin and with a thin cylindrical root sheath. Root cap short, slightly curved or nearly straight. Hibernacula or winter plants are merely reduced compact forms of the summer plants and may be with or without roots.

Reproduction is vegetative and similar to other species of the genus. Rare in flower. Spathe open; pistil short, clavate with a concave stigma and a



MAP No. 3
Lemna minor L.



MAP No. 4
Lemna minima Phillipi

solitary ovule, fruit elongated and erect; seeds oblong and pointed with about 16 ribs and many transverse striations. Found in habitats similar to those frequented by other species of the genus, although less shade tolerant than most of them.

Known in Indiana only from Allen, Cass, and Sullivan counties. The only Ohio record is from a pond in Paulding County within three or four miles of Allen County, Indiana.

Calif. to Wyo., Kans., Minn., Ind., and Ohio, southw. to Ga., Fla., La., Tex., Mex., and Cent. Amer. into S.A.

4. *Lemna perpusilla* Torr. Minute Duckweed. Map 5.—Plants oblong to obovate, strikingly unsymmetrical under vigorous growth conditions; internode abruptly narrowed to the point of abscission; faintly 3-veined; sessile or nearly so; cavernous throughout and provided with numerous stomata; apical dorsal papule prominent and frequently with a row of smaller papules along the midnerve; solitary or in groups of 2-6; green above and usually tinged with purple below; 1.2-2.5 mm wide by 2-2.5 mm long, being the smallest of the genus. Rather variable in form. A variety of this species (*trinervis*) with three prominent veins, more elongated and less symmetrical, occurs in some parts of the Mississippi Valley but has not been found in Indiana.

Roots, one from each plant, similar to those of *Lemna minor*. Root sheath with wings, varying from narrow to broad.



MAP No. 5

Lemna perpusilla Torr.

MAP No. 6

Lemna cyclostasa (Ell.) Chev.

Reproduction vegetative similar to that of *Lemna minor*. Flowers rare. Spathe open. Fruit unsymmetrical, ovoid to oblong ending in a prominent style. Seed slightly compressed, ovoid to obliquely oblong and oblique in the utricle. Seed coat thick with 12-16 prominent ribs and numerous transverse striations. Winter forms similar to those of *Lemna minor*.

Known range in Indiana restricted to four or five counties, all in the northern third of the state. The only Ohio record is from Mercer County within half a dozen miles of Randolph County, Indiana.

Nebr., N.Dak., Minn., Wis., Iowa, Ind., Ohio, N.Y., and Mass., southw. to Kans., Ark., Fla., and S.A.

5. *Lemna cyclostata* (Ell.) Chev. Pale Duckweed. Map 6.—Plants oblong to obovate-oblong, 0.7-1.9 mm wide and 2.3-4.5 mm long, usually distinctly unsymmetrical, especially near the base, or subfalcate; cavernous in the middle portion only; veinless or obscurely 1-veined; stomata numerous except near the borders. Variable in shape and color, a light yellowish green to apple green above and below. Sometimes found in dense tangled submerged masses or in balls several inches in diameter. Vigorous growth forms may develop a long conical papule at the node, another near the tip and 2-6 smaller ones along the midvein.

Roots long, 1-21 mm, commonly 6-14 mm, only one from each plant. Root sheath unappendaged. Root cap varying in length, tapering and curved. Winters in a slightly modified form of the summer plants, shorter, more rounded and more nearly symmetrical with tissues more compact and with roots shorter or entirely lacking.

Reproduction by the vegetative method by budding and abscission from paired reproductive pouches. Division much slower and growth much less vigorous than in *Lemna minor*. Extremely rare in flower. The spathe is reniform and the style long, and either straight or curved. The fruit is ovoid-oblong, rather unsymmetrical and about half the length of the plant itself. Seed oblong-ovoid with a thick coat, especially near the apex, and with 12-19 prominent ribs with numerous transverse striations.

Very locally distributed, being found at small isolated stations in completely stagnant water of bogs, swamps or ponds abundant in organic debris. This species has a pH tolerance range of about 5.2-7.7. Does not compete well with many of the other more vigorous duckweed species.

Known in Indiana only from Lagrange, Noble and Wells counties.

Nev. and Wyo. to Wis., Ill., Ind., Ohio, N.Y., and Mass., southw. to Calif., Tex., Fla., Jamaica, Mex., Cent. Amer., and S.A.

WOLFFIA Horkel

The Wolffias are minute, thick, globose or oblong-ovoid plants without roots or veins. The internodes early break by abscission. Vegetative growth

or flowering is by budding from the single reproductive pouch near the basal end of the plant. The inflorescence consists of a spadix, one stamen with unilocellate anther, and an ovary with one orthotropous ovule, the floral parts commonly breaking through the tissue of the upper part of the plant. Several species not known to flower. The fruit is smooth and spherical or short-ovoid and the endosperm is in a single layer.

The *Wolffias* resemble floating pinhead dots and are the smallest of all flowering plants. Their minute size can be appreciated by examination of the following data obtained by actual weighing and counts of sample portions of pure cultures of each species.

Species	Number of plants per square yard of water surface	Number of plants per gram.	Number of plants per pound.
<i>W. columbiana</i> -----	2,070,000	10,200	4,575,000
<i>W. punctata</i> -----	1,630,000	9,200	4,125,000
<i>W. papulifera</i> -----	1,420,000	7,200	3,225,000

One Ohio lake (Buckeye) had more than one square mile of water surface completely covered with *W. punctata* during the drouth year of 1933. A single acre of this plant contains a thousand times as many plant individuals as there are human beings in the whole world.

KEY

Plants globose or nearly so, not punctate, loosely cellular; upper surface convex with usually three inconspicuous papules; plant not prominent above the water line ----- 1. *W. columbiana*.

Plants more or less flattened above and gibbous beneath, brown-punctate, more compactly cellular; plant prominent above the water line.

Body of plant rounded-ovate, strongly gibbous, slightly unsymmetrical; dorsal surface with a single large conical papule ----- 2. *W. papulifera*.

Body of plant more or less oblong with upturned acute tip (peanut-shaped), slightly gibbous, symmetrical; dorsal surface with a prominent papule near the center ----- 3. *W. punctata*.

1. *Wolffia columbiana* Karst. Common *Wolffia*. Map 7.—Plants rootless, ellipsoidal to globose, unsymmetrical; upper surface convex with usually about three inconspicuous papules in a row along the median line; green throughout and very loosely cellular during the growing season; minute grains, resembling algae, floating at or just beneath the surface of the water, 0.3-0.9 mm wide by 0.32-1 mm long.

During unfavorable growth conditions green plants develop of greater density (hibernacula) which sink to the bottom and carry the plant over winter or through other unfavorable conditions.

Reproduction is vegetative by budding from the single funnel-shaped reproduction pouch. Young plants may remain attached to the parent plants for a considerable time. This species is the smallest flowering vascular plant in the world. Flowers, however, are very rare and difficult to detect because of their minute size. The spadix has one anther and the ovary a single ovule, the fruit being smooth and nearly spherical.

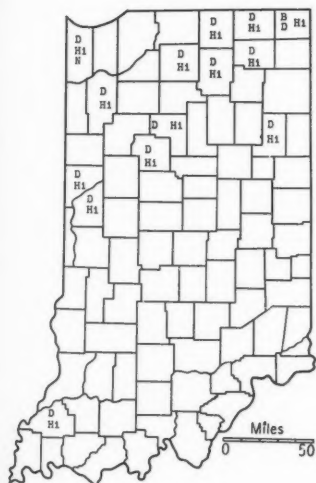
Locally very abundant in permanent stagnant waters. Usually found in small enclosed pools having abundant organic debris but in favorable years may compactly cover the entire water surface of many acres in the large lakes where protected from wave action. This species has a pH tolerance range of about 5.8-7.9 but is more frequent between pH 6.4 and pH 7.4.

Known from nearly a score of counties in the northern third of Indiana and along the lower Wabash River.

Minn., Wis., Mich., Ont., N. Y., Conn., and Mass., southw. to Fla., Tex., Mexico, Cent. Amer. and S. A.

2. *Wolffia papulifera* Thompson. Pointed Wolffia. Map 8.—Plants rootless, 1 mm wide by 1-1.5 mm long, slightly unsymmetrical, obliquely broadly ovate in horizontal outline; apex rounded with the upper surface flat at the margin and gradually ascending to form a single large conical papule on the median line; surface abundantly punctate with brown epidermal pigment cells above, lower surface strongly gibbous and with less punctation; stomata numerous and cells small above, cells much larger below; plant wintering by submerged hibernacula which are merely small, compact plants of the common vegetative stage.

Reproduction is rapid and entirely vegetative, consisting of budding from the single funnel-shaped reproductive pouch. The new plant usually separates



MAP No. 7

Wolffia columbiana Karst.

MAP No. 8

Wolffia papulifera C. H. Thompson

from the parent by rupture of the microscopic internode before reaching full size. Flowers very rare, being unknown until 1927.

Very restricted in distribution being found in isolated small colonies, sometimes with other species of the genus, more often in pure culture. Collected from permanent pools of stagnant water rich in organic matter.

Known in Indiana only from small ponds in Posey County. Described by Thompson in 1897 from Missouri and known today from only eight states: Kansas, Missouri, Arkansas, Tennessee, Kentucky, Illinois, Indiana, and Ohio.

3. *Wolffia punctata* Griseb. Dotted Wolffia. Map 9.—Plants rootless, symmetrical, elliptical to ovate-oblong, 0.32-0.57 mm wide by 0.58-0.96 mm long; upper surface flat or very slightly convex rising toward the acute apex like the bow of a boat, densely cellular and with numerous stomata above, more loosely cellular and with fewer stomata below; yellowish green to dark green above with a smooth, glossy surface unlike the granular appearance of *W. columbiana*, somewhat paler below. Plants usually floating with the entire upper surface exposed to the air, profusely brown-dotted throughout with minute pigment cells. Winters at the bottom of stagnant waters in the form of densely compact plants which are similar otherwise to the summer form.

Reproduction is vegetative by budding from the single funnel-shaped re-



MAP No. 9

Wolffia punctata Griseb.

MAP No. 10

Wolffella floridana (J.D.Smith) Thompson

productive pouch. Flowers and fruit extremely rare and almost unknown. The utricles are said to be ellipsoidal in shape.

Very restricted in distribution but may be extremely abundant locally, even on the larger lakes. Varies between wide extremes of abundance as growth conditions fluctuate. While occurring in fewer localities than *W. columbiana*, it frequently is the decidedly dominant form where it occurs, and, where favored by protecting vegetation, low water, and high temperatures during drouth years, may completely cover many acres of water surface. This species has a pH tolerance range of 6.0-7.7 with best growth from pH 6.4-7.4.

Known from about ten counties in northern and extreme southwestern Indiana.

Minn. to Mich., Ont., N.Y., and Conn., southw. to Tex., La., Fla., and Jamaica.

WOLFFIELLA Hegelm.

Plants thin, ligulate, curved and rootless, punctate on both surfaces with numerous brown pigment cells; commonly cohering into whorled, densely interwoven masses. Reproduction is vegetative by budding from the node at the base of the single wedge-shaped reproductive pouch located at the basal end of each plant. Flowers and fruit (if produced at all) are unknown.

1. *Wolffiella floridana* (J. D. Smith) Thompson. Star Wolffiella. Map 10.—Plants rootless, consisting of thin ribbonlike strips, solitary or commonly coherent for several generations forming clumps shaped like a rimless wheel or groups of clumps held in a butlike mass. Individual plants scythe-shaped or doubly curved, tapering from the broad, rounded, oblique base (nodal end) to a long, attenuated apex; plant 0.4-0.7 mm at the widest part by 4-14 mm long, being 14-21 times as long as wide; cavernous throughout except near the apex; submerged, or buoyant at the surface during the active growing season by the cavernous basal ends, frequently compacted with other organic debris such as floating clumps of cattail roots. Winters in a compact, submerged and more or less dormant state of the common vegetative form.

Flowers and fruit are unknown. The evolutionary development of this line has been such that the flowering potentiality has apparently been completely lost, i.e., inhibited by new inheritance. It is unlikely that flowers are ever produced in nature as plants cultured in the laboratory and subjected to more than a hundred sets of physiological conditions, have remained in the vegetative condition.

Restricted to wholly stagnant bodies of water. Usually found in boggy areas protected from wave action, with abundant accumulation of organic debris, and with acid water ranging from pH 4.7-6.8. Readily exterminated during drouth periods as waters recede, and very slow to be reintroduced and reestablished, hence restricted to old mature bodies of stagnant water with a long time record of water level maintenance. This species is less used for

food by either vertebrate or invertebrate animal organisms than any other duckweed.

Known in Indiana only from Marshall and Warren counties. Decidedly restricted in distribution in all of the northern states of its range, but sometimes abundant at some small isolated station, yet absent from contiguous areas of similar appearance.

Mo., Wis., Mich., and Ont., southw. to Tex., La., Fla., and Mex.

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Studies in *Penstemon* V. The Section *Peltanthera*¹

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The arid south-western United States contains a very large number of species of *Penstemon* and is one of the important centers for the distribution of this scrophulariaceous genus. The present paper deals with some of the showiest members of the entire genus, and, accordingly, several of these have received attention from the horticulturists. This section of *Penstemon* has received no treatment as a whole since the appearance of Gray's 'Synoptical Flora' over half a century ago, and as the intervening years have disclosed quantities of new facts, the present revision offers a new alignment of the systematic elements.

For the present study, collections in the following herbaria have been available to me, and for the privilege of their use I herewith acknowledge my indebtedness to the various curators.

C—University of California, Berkeley.

CAS—California Academy of Sciences, San Francisco.

CI—Carnegie Institution of Washington, Stanford University, Calif.

F—Field Museum, Chicago.

GH—Gray Herbarium, Harvard University.

M—Missouri Botanical Garden, St. Louis.

NY—New York Botanical Garden.

Ph—Academy of Natural Sciences, Philadelphia.

Po—Pomona College, Claremont, Calif.

RM—Rocky Mountain Herbarium, University of Wyoming, Laramie.

SU—Dudley Herbarium, Stanford University, Calif.

UAriz—University of Arizona, Tucson.

US—United States National Herbarium, Washington, D.C.

Utah—Utah State Agricultural College, Logan.

SCOPE OF THE REVISION

In the present paper a new section is proposed to accommodate an assemblage of species obviously linked by a number of characters in common. The boundary of the section is extended to include several groups, which may be designated as subsections, that have developed along somewhat diverse lines probably away from a common center, but it appears that a definite gap surrounds the groups included here so that the section stands, on morphological grounds at least, as a natural unit. In the 'Synoptical Flora,' Asa Gray treated these species as scattered parts of his section *Eupenstemon*, subsection *Genuini*. Pennell,² in his account of only the Rocky Mountain mem-

¹ Previous papers in this series have appeared as follows: I, Univ. Calif. Publ. Bot. 16:367-426, 1932; II, Madroño 3:200-219, 1936; III, *ibid.*, 3:248-250, 1936; and IV, Bull. Torr. Club 64:357-381, 1937.

² Contr. U. S. Nat. Herb. 20:313-381, 1920.

bers of the genus, distributed them among four species-groups numbered and named as: I *Centranthifolii*, III *Utahenses*, VII *Petiolati*, and VIII *Spectabiles*. These groups seem without doubt to be more closely related to each other than to the groups that were interspersed between them. In proposing the section *Peltanthera*, I segregate the species into four subsections, three of which correspond to Pennell's groups above mentioned excepting that I combine his first two into one, and the fourth is limited to Texas and New Mexico.

The present account deals with all the species of subsections *Petiolati* and *Spectabiles* but with only the six westernmost members of the *Centranthifolii* and with none of the *Havardiani*. This rather arbitrary limit to the paper is made necessary by limitations of time and the expectation that much more material will be available for study in the omitted group of species before an account of them is completed. In thus dividing the *Centranthifolii* it so happens that we are likewise dealing with the more thoroughly collected species. The species which are reserved for subsequent revision include *P. superbus* A. Nels., which apparently occurs from Graham and Cochise counties, Arizona, and Grant County, New Mexico, southward to Chihuahua; *P. Wrightii* Hook., of southwestern Texas; *P. Murrayanus* Hook., of eastern Texas and adjacent Louisiana and Oklahoma, and *P. rotundifolius* Gray, of Chihuahua. The *Havardiani* include *P. Havardi* Gray and *P. cardinalis* Woot. et Standl.

RELATIONSHIPS OF THE SECTION PELTANTHERA

The relationships of this section appear to be closest with the section *Cristati* of Pennell, l. c., for members of the two have ecological requirements in common, are often similar in habit, corolla-shape, -size, and -color, androecium, distribution of glands, pubescence of the flower, etc., but the gap is sufficiently wide between these sections so as to render quite worthless a suggestion regarding any particular species through which earlier connections between them might have been possible. Apparently many steps necessary to a complete phylogenetic picture of this connection have been wiped out. Another relationship may be pointed out, namely that between *Peltanthera* and *Elmigeria*, through such scarlet-flowered species as those of subsection *Havardiani* of the former and *P. Eatoni* of the latter. There is an approach toward the *Elmigeria* in the *Havardiani* in which the anthers fail to dehisce throughout and to become explanate while their sutures are denticulate-ciliate, but the dividing line seems to occur between these two groups rather than between the *Havardiani* and the *Centranthifolii*.

Within the *Peltanthera*, subsection *Petiolati* appears to be somewhat to the side of the main lines of development. It is probably a rather ancient type that finds more morphological affinity with members of subsection *Spectabiles* than elsewhere in the genus. Subsection *Centranthifolii* likewise contains species that find their nearest affinity outside the subsection with members of the *Spectabiles*. Here again the connecting links are lacking, but a relationship evidently exists between such species as *P. Clevelandii* Gray of the *Spectabiles* and *P. Parryi* Gray of the *Centranthifolii*. Similarities include habit, smooth glaucous herbage, tubular obscurely bilabiate flowers,

peltately explanate anthers and the included and peculiarly bearded staminode, while a principal difference involves the development of toothed leaves in the *Spectabiles* in contrast to the entire leaves of the *Centranthifolii*.

Peltanthera sect. nov.

Stems erect, few to many, strict, herbaceous throughout or from a suffrutescent or woody base, the herbage (below the inflorescence) usually glabrous and glaucous; leaves mostly coriaceous, principally cauline; inflorescence a virgate, rarely ample, thyrsus; corolla commonly glandular-pubescent, white, rose, blue-purple, crimson or scarlet; anther-sacs widely divaricate, mostly peltately explanate and glabrous. Type species, *P. spectabilis* Thurb.

KEY TO THE SUBSECTIONS AND SPECIES OF PELTANTHERA

- A. Leaves serrate or dentate (if entire, the corolla ventricose and not reddish); corolla usually ventricose and 2-lipped, never scarlet; usually suffrutescent at base.
 - B. Plant definitely shrubby, 1-2 dm tall; stems pruinose-puberulent; leaves only 10-25 mm long, all but the uppermost petiolate. Great Basin ----- I. Subsection PETIOLATI
 - A monotypic subsection. ----- 1. *P. petiolatus*
 - BB. Herbaceous or suffrutescent (\pm shrubby in 5 and 11), 3 dm or more tall; stems glabrous; leaves mostly larger, only the basal petiolate. ----- II. Subsection SPECTABILES
 - C. Corolla abruptly inflated from a short tube ca. equaling the calyx, strongly 2-lipped, white, tinged with pink or lavender or purple, mostly 12 mm or more wide; staminode long-bearded.
 - D. Leaves obviously dentate, lance-ovate, 10 mm or more wide; inflorescence glandular-pubescent (except in 2b); stems rarely branched.
 - E. Upper leaves connate-perfoliate, glaucous; ovary usually glandular-puberulent; staminode exserted, uncinat; thyrsus virgate. Southern Great Basin. ----- 2. *P. Palmeri*
 - EE. Upper leaves distinct, usually bright green; ovary glabrous.
 - F. Staminode very short, well included, straight, dilated throughout; corolla 15-20 mm wide; thyrsus virgate. Baja Calif. ----- 3. *P. eximius*
 - FF. Staminode exserted, uncinat, scarcely dilated; corolla 10-15 mm wide; thyrsus lax. Montane southern Calif. ----- 4. *P. Grinnellii*
 - DD. Leaves essentially entire and linear, up to 6 mm wide; inflorescence glabrous, a lax thyrsus; stems freely branched; staminode exserted, uncinat. Ranges about Death Valley. ----- 5. *P. fruticiformis*
 - CC. Corolla nearly tubular to inflated from a tube twice longer than calyx, not whitish; staminode short-bearded or glabrous, not uncinat.
 - G. Anther-sacs peltately explanate and glabrous (except 9d); thyrsus virgate (sometimes \pm open in 9); corolla pink to rose-purple.
 - H. Corolla obviously 2-lipped and strongly inflated (except 7b), more than 10 mm wide (except 7b); leaves glaucous.
 - I. Corolla 27-35 mm long, the limb glandless but at lower lip villous; staminode exserted, bearded. Mineral Co., Nev. ----- 6. *P. rubicundus*

- II. Corolla 22-30 mm long, the limb viscid-puberulent but not villous; staminode included, not bearded. White, Inyo and Panamint ranges -----7. *P. floridus*
- HH. Corolla nearly regular and tubular-funnelform (except 8c), up to 9 mm wide (to 12 mm wide in 8c); leaves green or \pm glaucous (always glaucous in 10); staminode included.
- J. Calyx 4-6 mm high; corolla moderately amplate, the throat longer than the tube, 5-12 mm wide.
- K. Corolla pink to rose-purple, with dark guide lines, 20-30 mm long; leaves thin, finely serrate-dentate; stems to 10 dm tall. Eastern Calif. to N. Mex. -----8. *P. pseudospectabilis*
- KK. Corolla crimson or red-purple, without guide lines, 17-24 mm long; leaves thick, entire to sharply dentate; stems to 7 dm tall. Western borders of Colorado Desert, Calif., to Baja Calif. -----9. *P. Clevelandii*
- JJ. Calyx 2-3 mm high; corolla essentially tubular, the throat no longer than the tube, 4-5 mm wide. Providence Mts. -----10. *P. Stephensii*
- GG. Anther-sacs not explanate, \pm scabro-ciliate about suture; thyrsus lax (the peduncles divaricate); corolla purplish with blue limb, obviously 2-lipped; staminode included.
- L. Leaves narrowly linear-lanceolate and mostly entire; inflorescence glandular-pubescent; staminode bearded. Western Mohave Desert. -----11. *P. incertus*
- LL. Leaves broader, the upper connate-perfoliate, coarsely serrate (except 12b); inflorescence glabrous (except 12c); staminode glabrous (except 12b). Cismontane southern Calif. to Baja Calif. -----12. *P. spectabilis*
- AA. Leaves entire; corolla tubular, usually nearly regular, scarlet to carmine, rarely rose-purple; herbaceous throughout.
- M. Corolla not constricted at orifice, the lobes all spreading; anthers petalately explanate and glabrous (cf. 17). -----III. Subsection CENTRANTHIFOLII
- N. Pedicels and calyces glandular-pubescent; lower cauline leaves \pm reflexed; corolla glandular. Cedros Island. -----13. *P. cerrosensis*
- NN. Pedicels and calyces essentially glabrous; lower cauline leaves erect.
- O. Corolla glabrous without and within, scarlet, tubular.
- P. Cauline leaves 10-30 mm wide; corolla 25-33 mm long, Cismontane Calif. -----14. *P. centranthifolius*
- PP. Cauline leaves 2-8 mm wide; corolla 18-26 mm long, Arizona. -----15. *P. subulatus*
- OO. Corolla glandular-pubescent without and within (except 17b), carmine to rose-lavender.
- Q. Staminode glabrous or papillate-bearded. Great Basin Plateau.
- R. Corolla 18-24 mm long, tubular, carmine, viscid within; anther-sacs broader than long; staminode usually glabrous. -----16. *P. utahensis*
- RR. Corolla 14-20 (-22) mm long, slightly amplate, reddish purple to rose-lavender, viscidulous or glabrous within; anther-sacs longer than broad; staminode usually papillate-bearded. -----17. *P. confusus*

- QQ. Staminode prominently bearded; corolla rose, ampliate.
 Sonoran Desert. -----18. *P. Parryi*
 MM. Corolla constricted at orifice, the limb very short, the upper lip erect, the
 lower lip reflexed; anther-sacs not explanate, ciliolate-denticulate. ----
 -----IV. Subsection HAVARDIANI

SUBSECTION I. PETIOLATI

A monotypic subsection based upon the following anomalous species.

1. *Penstemon petiolatus* Brandegee
 (Fig. 1).

Penstemon petiolatus T. S. Brandegee, Bot. Gaz. 27:455, 1899.

P. calcareus Jones, Contr. West. Bot. 12:60, 1908, not Brandegee, 1903. "This looks like a diminutive *P. spectabilis*, but is a very well defined species, growing in very hot and dry and exposed places on rocky limestone ridges and slopes near Indian Springs, Charleston Mts., Nevada, at 4000 feet altitude, May 7, 1906 [M. E. Jones]."

P. aboriginum Jones, *ibid.* 14:35, 1912. New name for *P. calcareus* Jones.

Plants shrubby, low, 1-2 dm tall, the several stems branching from the woody base, pruinose puberulent; leaves glabrate to pruinose-puberulent, glaucous or green, subentire to sharply serrate, broadly ovate, obtuse or acute, 10-25 mm long, all but the uppermost petiolate; thyrsus ovate, compact, the herbage sparingly glandular; peduncles divergent, 1-5-flowered; calyx 5-6.5 mm high, the lobes lance-ovate; corolla "violet" (Purpus), "deep pink drying to purple" (Jones), with faint guide lines, 15-17 mm long, 5 mm wide at throat, prominently bearded across base of lower lip, tubular-funnelform, the tube proper well exceeding the calyx, scarcely shorter than the gradually ampliate throat, the quadrate lobes spreading or reflexed; anther-sacs as broad as long; all filaments glabrous throughout, the staminode scarcely dilated, exserted.

A rarely collected species of the arid ranges of southern Nevada and southwesternmost Utah. Type: "Sheep mountain, Nevada, at 5000 ft. altitude, Dr. C. A. Purpus, no. 6136."

UTAH. Washington Co.: Beaver Dam Mts., 24 mi. W. of St. George, April 24, 1879, Siler (GH, Ph).

NEVADA. Clark Co.: Sheep Mountain (possibly on the Lincoln Co. side), Purpus 6136 (C, type; isotypes NY, Ph, US); Indian Spring, Charleston Mts., May 7, 1906, Jones (Po, type of *P. aboriginum*; isotypes C, F, GH, M, SU, US).

This species is peculiarly noteworthy on account of its depressed shrubby habit, its pruinose puberulence, and its extensively petiolated and very small leaves. Jones states that the plants form open mats one to two feet in diameter. The exserted stamens in themselves are somewhat suggestive of the *P. Palmeri* group of species, but the pubescence of the corolla and its parts and the flower-shape are indicative of a connection with the *P. Clevelandii*-*P. Stephensii* complex. Morphologically, it approaches most closely to *P. Clevelandii* subsp. *mohavensis*, but any possible connection that existed here must have been dissolved at a very early period. *P. petiolatus* is clearly the best marked of any species in the section.

SUBSECTION II. SPECTABILES

Stems usually many, erect, herbaceous, from a suffrutescent base, glabrous below the inflorescence and often glaucous; leaves glabrous, glaucous, coriaceous, the basal with a usually winged petiole shorter than the blade, the cauline sessile or connate, the floral abruptly reduced; calyx-lobes often longitudinally veined, the narrowly hyaline margin entire or rarely erose; corolla usually glandular-pubescent without and within throat, the lobes quadrate; anther-sacs widely divaricate, peltately explanate and glabrous (cf. 9d, 11 & 12). Based upon *P. spectabilis* Thurb.

2. *Penstemon Palmeri* Gray

(Fig. 1).

Penstemon Palmeri Gray, Proc. Amer. Acad. 7:379, 1868.

Stems 5-14 dm tall; leaves gray-glaucous, irregularly spinulose dentate or the uppermost subentire, the basal oblong-ovate, the cauline lance-ovate, obtuse or acute, auriculate-clasping at base, the upper pairs usually connate-perfoliate, the largest to 15 cm long and to 9 cm wide, usually considerably smaller; inflorescence a virgate thyrsus, often half as tall as the plant; peduncles and pedicels suberect, short, subequal; cymes 2-3-flowered; calyx 4-6 mm high, the lobes broadly ovate; corolla whitish suffused with pink or lilac, with prominent dark red or maroon guide lines extending from lower lip to tube, 22-35 mm long, 10-20 mm wide, the short tube abruptly expanding on all sides into a strongly inflated and ringent throat with reflexed lobes, villous across base of lower lip; anther-sacs longer than broad; the shorter pair of fertile filaments glandular-puberulent at their dilated bases; staminode exerted, scarcely dilated, uncinat, densely bearded with shaggy flattened yellow hairs 3 mm long on the dorsal side apically, glandular-pubescent at base; style toward base and ovary usually somewhat glandular-puberulent.

KEY TO SUBSPECIES

- Calyx, pedicel and peduncle glandular-pubescent.....2a. *P. P.* subsp. *typicus*
 Calyx, pedicel and peduncle glabrous.2b. *P. P.* subsp. *eglandulosus*

2a. *Penstemon Palmeri* subsp. *typicus* nom. nov.

Penstemon Palmeri A. Gray, l. c.

P. macranthus Eastw., Bull. Torr. Club 32:207, 1905. "Collected in IXL Canon, Churchill County, Nevada, June 15, 1902, by Otto F. Heizer." Not separable from material to the eastward, the slightly longer tube of the corolla not being sufficiently distinctive and yet the only detectable difference.

Frequent in desert washes on sagebrush-covered slopes in adjacent portions of Utah, Nevada, Arizona and California at elevations of 1000 to 2400 meters. Type locality: "—Arizona, in Skull Valley, and on Rio Verde, near Fort Whipple, Drs. Elliot Coues and Edward Palmer."

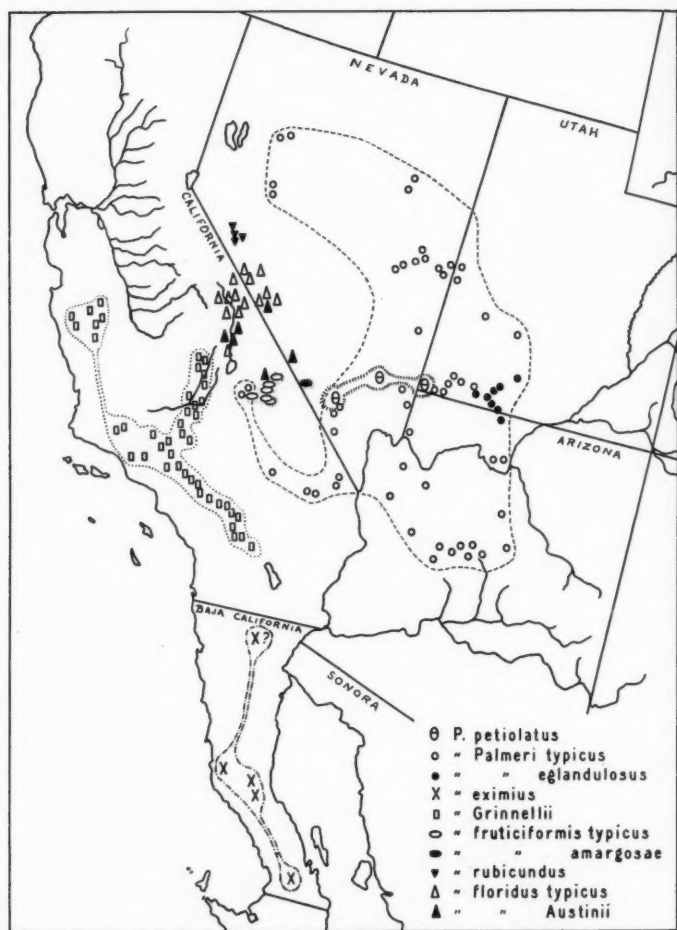


Fig. 1. Distribution of *Penstemon*, section *Peltanthera*, subsections *Petiolati* (complete) and *Spectabiles* (in part).

UTAH. Millard Co.: Simonsen's Ranch, *Maguire & Becraft* 2792 (C, GH, Utah); Garrison, *Keck* 631 (C,CAS,CI,M,Ph,Po,SU). Beaver Co.: Frisco, *Jones* 1820 (CAS,CI,F,NY,SU,US), *Keck* 635 (C,CI,GH,NY,Ph,SU); 10 mi. E. of Beaver, *Keck* 648 (CAS,CI,Ph,SU). Washington Co.: Zion National Park, *Eastwood & Howell* 1153 (CAS); Pine Valley, *Baker* 8422 (C,CI,Ph,SU); Pine Valley Mts., *Maguire & Richards* 13114 (Utah); St. George to Pine Valley, *Eastwood & Howell* 1224 (CAS,CI); St. George, 1875, *Palmer* (GH); 12 mi. W. of St. George, *McKelvey* 4179 (CI).

ARIZONA. Coconino Co.: Grand Canyon, Kaibab trail to Roaring Springs, *Eastwood & Howell* 1009 (CAS); Grand Canyon, Grand View Trail, *Eastwood* 5692 (CAS); San Francisco Peak, *Jones* 4107 (C,SU,Utah); Snebly Hill, near Sedona, *Gooding* 20 (CI,SU). Mohave Co.: Horse Spring, *Jones* 5068 (C,US); between Music Mt. and Clay Springs, *McKelvey* 4089 (CI, Ph); Peach Springs, May 26, 1884, *Jones* (C,CAS,CI,SU,US); Burro Creek, Aquarius Mts., *Eastwood* 18382 (CAS); Kingman, *Eastwood* 18078 (CAS). Yavapai Co.: 20 mi. S. of Sedona, *Whiting* 1207 (CI); Soda Springs on Beaver Creek, 13 mi. above Camp Verde, *Wolf* 2403 (CAS,GH,SU); Jerome, May 23, 1920, *W. W. Jones* (C); 11 mi. W. of Jerome, *Wolf* 2387 (CAS,GH,SU); Dewey, *McKelvey* 1200 (GH); Davy to Prescott, *Eastwood* 17626 (CAS,CI,GH); Iron Springs, June 20, 1928, *Carter* (CI); Fort Whipple, *Coues & Palmer* 472 (GH, cotype); Skull Valley, *Coues & Palmer* 228 (GH, type).

NEVADA. Elko Co.: Cave Creek, Ruby Mts., *Keck* 935 (CAS,CI,Ph,SU), *Heller* 9518 (NY,Ph,US); Ruby Valley, *Watson* 779 (US). Pershing Co.: Trinity Mts., *Watson* 779 (GH); between Lovelock and Imlay, *Eastwood & Howell* 138 (CAS, CI); 8 mi. S. of Imlay, *Benson* 6714 (CI). Churchill Co.: mts. E. of Stillwater, *Headley* 52 (US); I X L Canyon, June 15, 1902, *Heizer* (CAS, type of *P. macranthus*). White Pine Co.: 17 mi. N. of Baker, *Maguire & Becraft* 2791 (C, Utah); W. of Baker, *Tidestrom* 11136 (US); 20 mi. E. of Ely, *Keck* 625 (CI, Copenhagen, SU); 7 mi. E. of Ely, *Hitchcock* 1283 (US); Ely, *Hitchcock* 1203 (US), *Howell* 7957 (CAS,CI); Ward, 1884, *Clements* (GH); Currant Summit, *Keck* 609 (CI,NY,SU). Nye Co.: Currant, *Keck* 584 (Berlin, C,CAS,CI,GH,Kew, M,Po,SU). Lincoln Co.: Pioche, *Minthorn* 91 (C); Mormon Mts., *Kennedy & Gooding* 107 (C,SU). Clark Co.: Lee Canyon, Charleston Mts., *Heller* 10996 (C,F,GH,M,NY,Ph,SU,US); Kyle Canyon, ditto, *Tidestrom* 9591 (Ph); Bunkerville, Virgin River, *Gooding* 745 (GH); Good Springs, *Ferris* 7339 (SU).

CALIFORNIA. Inyo Co.: Darwin Falls, Argus Mts., *Ferris* 7721 (SU); Crystal Spring, Coso Mts., *Coville & Funston* 919 (GH, US). San Bernardino Co.: Ivanpah, *Ferris & Bacigalupi* 8097 (C, SU); Barnwell, May 1911, *K. Brandegee* (C); Bonanza King Mine, Providence Mts., *Ferris & Bacigalupi* 8150 (C,SU), *Munz, Johnston & Harwood* 4276 (C,Po,SU); Kelso, May 2, 1906, *Jones* (Po,SU); Mohave River district, *E. Palmer* 331 (C).

2b. *Penstemon Palmeri* subsp. *eglandulosus* subsp. nov.

A subsp. typica differt caulibus, pedunculis, pedicellis calycibusque glaberrimis.

Type: *Bassett Maguire, Ruth Maguire & George Piranian* no. 12279, from base of red sandstone cliffs 2.5 mi. north of Kanab, Kane County, Utah, June 29, 1935, Intermountain Herbarium, Utah State Agricultural College, no. 18907; isotypes CI, Ph.

Locally common in Garfield and Kane counties, Utah, and adjacent portion of Coconino County, Arizona.

UTAH. Garfield Co.: Bryce Canyon, July 10, 1932, *Hawver* (CAS). Kane Co.: Hidden Lake, *Eastwood & Howell* 804 (CAS); 30 mi. N. of Kanab, *Goodman & Hitchcock* 1623 (C,CAS,SU); between Kanab and Orderville, *McKelvey* 4361

(CI, Ph); Kanab, *Jones* 25575 (SU). Washington Co.: Zion Canyon, May 21, 1923, *Jones* (SU); Little Zion, May 21, 1918, *Jones* (Pullman).

ARIZONA. Coconino Co.: House Rock, *Jones* 25576 (SU).

The following collections from Utah are intermediate between this and subsp. *typicus*: Bryce Canyon, June 30, 1923, *Rodda* (CAS); Kanab Canyon, *Eastwood & Howell* 832 (CAS, CI).

3. *Penstemon eximius* sp. nov.

(Fig. 1)

Herba perennis 6-15 (-20) dm alta; caulibus multis erectis e basi suffrutescente virgatis glabris; foliis glabris viridibus coriaceis argute spinosodentatis, inferioribus ovato-lanceolatis lamina usque ad 12 cm longa et 4.5 cm lata acuta in petiolum marginatum angustatis, superioribus lanceolatis cordato-amplexicaulibus, floralibus parvis; thyrsos virgatos 3-6 dm longo 4-5.5 cm lato glanduloso-pubentibus; pendunculis erectis 2-4-floris; sepalis 5-7 mm longis ovato-oblongis obtusis margine angustissime scariosis integris; corolla albescente (roseo suffusa) 23-30 mm longa 15-20 mm lata viscidula, fauce e tubo brevi subito maxime ventricosampliatam limbo ringente duplo longiore, labio inferiore basi intus villosa profunde 3-loba, lobis latis; staminibus fertilibus inclusis glaberrimis, loculis antherarum suboppositis peltate explanatis 2 mm longis 2 mm latis, staminodio brevi (9-10 mm longo) dilatato longitudinaliter longe barbato basi glanduloso-puberulente.

The scattered stations for this species reach throughout the arid regions of the Northern District of the peninsula of Baja California, Mexico.

Type: *Ira L. Wiggins* no. 4370, Dudley Herbarium of Stanford University, no. 244448, collected in a rocky wash $\frac{1}{4}$ mi. west of El Marmol, Baja California, March 6, 1930; isotypes C, CI, GH, Ph, US. This collection bears the note, "Plant of about 8 stems, each from 4 to 6 feet high; corolla nearly white with purplish veins and tinged at base of tube."

Other collections studied are from Baja California as follows: San Luis (northwesterly from Calmalli), Apr. 27, 1889, *T. S. Brandegee* (C); Catavina, Apr. 4, 1935, *C. F. Harbison* (Herb. San Diego Soc. Nat. Hist.); San Juan de Dios (10-12 mi. E. of Rosario), 1927, *Canfield* (Herb. San Diego Soc. Nat. Hist.). Doubtless the same is *Orcutt* 1117, from Canyon Cantillas, northern Baja California (C, GH), but the scrappy specimens in old fruit cannot be positively placed.

Brandegee³ states (under the name of *P. Palmeri* Gray) that he obtained this at San Luis and Agua Dulce and that it was "eight feet high." I have not seen the latter specimen but it undoubtedly is to be referred here as the San Juan de Dios station is not far to the west of Agua Dulce. Such a height is greater than that recorded for any other species in this section, and, judging from the foliage and flowers, *P. eximius* must rival *P. Palmeri* in beauty.

³ Proc. Cal. Acad. Sci. ser. ii, 2:191, 1899.

These two species may be immediately distinguished from each other by the very great difference in the length of their staminodes, *P. eximius* in proportion to the size of its flowers having the shortest in the section—*P. Palmeri* the longest. Secondary characters include the absence of connate-perfoliate leaves in *P. eximius*, its non-glaucous stems and foliage, the shorter beard on its staminode, and the lack of glands on the fertile filaments. Of outstanding importance is the consideration that the two species are separated by 200 miles (320 kilometers). *P. eximius* is more distantly related to the other species of the section and may be considered a scion of *P. Palmeri* stock.

4. *Penstemon Grinnellii* Eastwood

(Fig. 1)

Penstemon Grinnellii Eastw., Bull. Torr. Club 32:207, 1905.

P. scrophularioides M. E. Jones, Contr. West. Bot. 12:65, 1908. "This has been confounded with *P. Palmeri* of the interior but is very different. The flowers in the bud closely resemble those of *Scrophularia*. Keane, California, May 21, 1903 [Jones]." This is Keene, Tehachapi Mts., Kern County, and the form represented is the usual one from Greenhorn Mts. and Kern Canyon to the Tehachapi region with rather tall stems.

P. Palmeri var. *Grinnellii* Munz et Johnst., Bull. Torr. Club 49:42, 1922.

P. hians Johnston, Contr. Gray Herb. n. s. 68:92, 1923. "California: San Benito River, San Benito County, May 25, 1915, Hall 9924 (type, Gray Herb.)."

Stems branching below, 3-8 or 10 dm tall; leaves green or somewhat glaucous, finely to coarsely spinulose dentate or the uppermost entire, the basal broadly lanceolate, the cauline lanceolate to ovate-oblong, obtuse or acute, the uppermost broadly sessile but distinct, the largest to 8 cm long, to 3 cm wide; inflorescence a lax thyrsus 4-8 cm broad, glandular-pubescent; peduncles and pedicels divergent, 1-3 cm long, subequal; cymules 2- or 3-flowered; calyx 4-6 mm high, the lobes broadly ovate; corolla nearly white or pale purplish or bluish with the color much deeper within than without, with dark guide lines running from lower lip to base of throat, 20-30 mm long, 10-15 mm wide, the short tube abruptly expanding just above the calyx on all sides into a strongly inflated and ringent throat with reflexed lobes, or the upper lip projected, villous across base of lower lip; anther-sacs longer than broad; the shorter pair of fertile filaments glandular-puberulent at their dilated bases; staminode exerted, scarcely dilated, uncinate, densely bearded with shaggy flattened yellow hairs on the dorsal side apically, \pm prominently glandular-pubescent along the basal half; ovary usually glabrous.

Occasionally in the South Coast Range and the southern Sierra Nevada, common from the Greenhorn Range and Mt. Pinos southward through the mountains to the San Jacinto Mts., all in California, at elevations of 800 to 2900 meters. Type locality: "Mt. Wilson."

CALIFORNIA. San Benito Co.: New Idria Canyon, May 31, 1899, Dudley (SU); San Benito River, Hall 9924 (GH, type of *P. hians*, isotypes C, US); Hernandez, June 1903, Lathrop (SU); Lewis Creek, May 14, 1893, Eastwood (GH), Keck 2851 (C,CAS,CI,SU). Monterey Co.: Tassajara Hot Springs, Elmer 3370 (SU,US);

China Camp, *Shreve* 59 (Desert Lab.); China Camp to Tassajara Hot Springs, *Baker* 7846 (CI); Mustang Grade, *Keck* 2849 (Berlin, Copenhagen, C.CAS, CI, F, GH, Geneva, Kew, M. ND, NY, Ph, Po, RM, SU, UCLA, UMontana, US). Tulare Co.: Mineral King to Camp Lewis, 2 mi. NW. of Rifle Creek, *Baker* 4407 (CI, SU); N. Little Kern River, *Purpus* 1372 (C); Little Kern Lake, Culbertson in *Baker* 4278 (GH); Trout Meadows, *Hall* 8381 (C); Soda Spring, head of Kern River, *Dudley* 1920 (SU); Kern River at Rock Creek Fork, *Hall & Babcock* 5562 (C). Kern Co.: *Onyx*, *Voegelin* 135 (C); Kern Canyon 7 mi. above Kernville, *Howell* 5040 (CAS); Kern River at Cannell Creek, *Peirson* 8833 (CI); Greenhorn Mts., *Weston* 119 (CAS); Pah Ute Peak, *Purpus* 5307 (C, GH, US); Mt. Breckenridge, *Benson* 3367 (C, SU); Kern River Canyon, 9 mi. above mouth, *Keck & Stockwell* 3260 (C, CAS, CI, GH, Ph, Po, SU, US); Keene, May 22, 1903, *Jones* (Po, type of *P. scrophularioides*, isotypes Ph, SU); Bisses Station, *Dudley* 444 (SU, US); 4-5 mi. S. of Tehachapi, *Wolf* 2201 (CAS, GH, SU); San Emigdio Canyon, *Davy* 2002 (C); Cuddy Canyon near Lebec, *Epling & Wheeler* 1845 (C, CI, SU); Frazier Mt. Park, *Howell* 3825 (CAS, CI). Santa Barbara Co. (?): Cuyama Canyon, Apr. 28, 1926, *Jones* (CAS, GH, SU). Ventura Co.: Seymour Creek, Mt. Pinos, *Hall* 6340 (C, SU); Frazier Borax Mine, Mt. Pinos, *Abrams & McGregor* 268 (GH, SU, US); Topatopa Mts., *McMinn* 1132a (SU); Matilija Canyon, Ojai vicinity, Apr. 25, 1866, *Peckham* (US). Los Angeles Co.: Kings Canyon, *Liebre Mts.*, *Dudley & Lamb* 4354 (SU); Oakgrove Canyon, *Liebre Mts.*, *Abrams & McGregor* 335 (SU, US); Acton, Mt. Gleason, *Elmer* 3615 (C, GH, SU, US); Sister Elsie Peak, June 10, 1916, *Grinnell* (CAS); Spunky Canyon, off Bouquet Canyon, *MacFadden* 2633 (C); Rock Creek, *Abrams & McGregor* 552 (SU); Mt. Wilson, June 6, 1903, *Fordyce Grinnell, Jr.* (CAS, type), *Abrams* 2579 (GH, SU, US), *Eastwood* 9021 (CAS, US); Barley Flats, *Ewan* 4272 (C); North Baldy Mt., *Abrams & McGregor* 575 (GH, SU, US). San Bernardino Co.: Ontario Peak, *Johnston* 1526 (C, SU); North Fork, Deep Creek, July 1921, *Johnston* (US); Lake Arrowhead, *Braunton* 1054 (SU); Crystal Creek, *Munz & Hitchcock* 12795 (C, Po); City Creek Grade, June 24, 1926, *Jones* (C, CAS); Big Bear Lake, *Howell* 2742 (CAS); Upper Santa Ana Canyon, *Hall* 7523 (C, US); S. Fork, Santa Ana River, *Grinnell* 222 (CAS, US); Dollar Lake, *Wheeler* 1052 (CI); Mill Creek, *Parish* 5056 (SU, US). Riverside Co.: Banning, May 28, 1928, *Van Dyke* (CAS); Fuller Mills Mts., San Jacinto Mts., *Hall* 2548 (C, SU); Stone Creek, July 10, 1921, *Jaeger* (SU, US); 12 mi. N. of Idyllwild, June 20, 1926, *Jones* (CAS, GH, SU); Idyllwild, *Spencer* 1230 (CAS, GH); Santa Rosa Mts., *Munz* 5826 (Po).

As a result of studying this species in the field and in the experimental garden, I have concluded that it cannot be readily broken up into geographical subunits. True, material from San Benito and Monterey counties is uniformly taller, more glaucous and bluer-flowered than that in the southern California mountains, yet it is not readily separable by these relative characters. Still less is there a genuine distinction between the two in flower-size or -shape or in the number of glands, which were characters pointed out by Johnston in describing *P. hians*. The Tehachapi form (*P. scrophularioides*) is indistinguishable from the material in the South Coast Ranges. But by minute degrees it passes into the shorter forms found at higher elevations, and flower-color, flower-size, color of the foliage, and degree of openness of the inflorescence vary without regard for geographic lines.

Also, from field and garden comparisons it is evident that this species is clearly and neatly set off from *P. Palmeri* of the deserts by a number of characters, whose cumulative effect is much more strikingly manifest in a side by side comparison of living plants than in an examination of herbarium sheets.

5. *Penstemon fruticiformis* Coville

(Fig. 1)

Penstemon fruticiformis Cov., Contr. U. S. Nat. Herb. 4:170, 1893.

Stems much branched from the shrubby base, 3-6 dm tall; leaves entire or rarely obsoletely denticulate, narrowly linear-lanceolate, to 6 mm wide, the margin \pm involute, the lower narrowed to a winged petiole, the upper sessile; inflorescence a lax thyrus only 1/4-1/6 the height of the plant, glabrous; peduncles merely divergent, 1-3-flowered, 1-3 cm long, \pm equaling the erect unequal pedicels; calyx 5-7 mm high, the lobes ovate to nearly rotund, abruptly acute to short-acuminate; corolla whitish to pale pink or flesh color, the limb darker, usually lavender-blue, with purplish guide lines extending from lower lip into throat, 20-27 mm long, 10-13 mm wide, the short tube (scarcely exceeding the calyx) abruptly expanding on all sides into a strongly inflated and ringent throat, glabrous without, even in bud, or sparingly glandular-puberulent in subsp. *amargosae*, glandular-pubescent within, strongly villous across base of lower lip, the upper lip projecting, the lower lip reflexed; anther-sacs longer than broad; the shorter pair of fertile filaments glandular-puberulent at their dilated bases; staminode exerted, moderately dilated apically, uncinat, densely bearded with shaggy flattened yellow hairs on the dorsal side for outer 1/3 its length, prominently glandular-pubescent on all sides for basal third.

KEY TO SUBSPECIES

- Corolla glabrous without, \pm densely glandular-pubescent within throat; calyx-lobes rotund-ovate. ----- 5a. *P. f.* subsp. *typicus*
 Corolla glandular-pubescent without, scarcely at all glandular within throat; calyx-lobes lance-ovate. ----- 5b. *P. f.* subsp. *amargosae*

5a. *Penstemon fruticiformis* subsp. *typicus* nom. nov.*Penstemon fruticiformis* Cov., l. c.

Frequent in canyons of the Panamint and Argus ranges, to the west of Death Valley, southern Inyo County, California, at elevations of 1100 to 2300 meters. Type locality: "Wild Rose Canyon, Panamint Mountains, Inyo County, California."

CALIFORNIA. Inyo Co.: west arm of Dead (Death) Valley, Purpus 5929 (C); Wild Rose Canyon, June 24, 1891, Bailey [Coville & Funston 2044] (US, type), Hoffmann 457 (CAS); Surprise Canyon, Ferris 7981 (C.CI.SU), Howell 3922 (CAS.CI); Panamint (Surprise) Canyon, Hall & Chandler 7028 (C.RM.SU), May 4, 1897, Jones (M. NY); Pleasant Canyon, Panamint Mts., Hall & Chandler 6928 (C.M.Ph.US); Rose Spring Canyon, Argus (Coso?) Mts., Purpus 5370 (C.GH.M.NY.US).

5b. *Penstemon fruticiformis* subsp. *amargosae* subsp. nov.

A subsp. *typica* differt sepalis ovato-lanceolatis, corolla extus glandulari-pubescente, intus vix glandulosa.

Type: from the Amargosa Desert, Nye County, Nevada, at 1220 m.

elevation, collected April 27, 1907, by *Marcus E. Jones*, Herbarium of Pomona College, no. 206551; isotype CI.

Known only from the type collection, made in the region to the east of Death Valley, not far from the California state line.

6. *Penstemon rubicundus* sp. nov.

(Fig. 1)

Herba perennis 5-12 dm alta; caulibus multis erectis e basi suffrutescente glabris glaucis; foliis glaucis crassiusculis, inferioribus oblongo-ovatis argute denticulatis in petiolum marginatum angustatis, superioribus ovato-lanceolatis cordato-amplexicaulibus distinctis saepe subintegris 5-10 cm longis 2-5 cm latis; thyrsos virgatos usque ad 9 dm longo parce glanduloso-pubentibus; pedunculis erectis brevibus 2-4-floris; sepalis 4-5 mm longis paulo accrescentibus ovatis acutis; corolla rubicunda (rosea) 27-35 mm longa 10-15 mm lata extus glanduloso-pubescente intus supra dense viscido, fauce e tubo calyce duplo longiore paulatim latissime campanulato-ampliata, ore hiantes, labio inferiore basi intus moderate villosa, lobis recurvis; staminibus fertilibus glabris vel basi minute viscido-puberulente, loculis antherarum suboppositis peltate explanatis 1.5 mm longis 1 mm latis, staminodio exserto apice incurvo insigniter flavo-barbato, barba 1.5-2 mm longa.

Type: *A. A. Heller* no. 10901, from canyon at southerly base of Mount Grant, Wassuk Range, Mineral County, Nevada, at 1430 m. elevation, July 2, 1913, deposited at the Academy of Natural Sciences of Philadelphia, no. 558362; isotypes C, GH, SU.

Known only from the Wassuk Range, in Mineral County, Nevada. Additional collections: Hawthorne, June 23, 1882, *Jones* (SU); Hawthorne, Big Indian Canyon, May 27, 1897, *Jones* (NY, US, Utah); Corey Canyon, *Tidestrom* 10117 (Ph).

This handsome species stands between *P. Palmeri typicus* and *P. floridus typicus* both geographically and morphologically. Very possibly *P. rubicundus* originally arose through hybridization between the two, but at the present time the nearest known station to it of the former species is 65 miles to the northward and of the latter, 40 miles to the southward.

The shape and size of the corolla, with its glandless but villous limb, and the exserted staminode, with its prominent beard, easily distinguish *P. rubicundus* from *P. floridus*. On the other hand, the gradually inflated corolla of deep rose-pink color and long tube and anthers of only half the size, together with the short beard of the staminode and the absence of connate-perfoliate leaves, readily separate it from *P. Palmeri*.

7. *Penstemon floridus* Brandegee

(Fig. 1)

Penstemon floridus T. S. Brandegee, Bot. Gaz. 27:454, 1899.

Stems 6-12 dm tall; leaves gray-glaucous, irregularly spinulose dentate or the uppermost subentire, the basal oblong-ovate, the cauline lance-ovate, most-

ly obtuse, sessile or auriculate-clasping at base but distinct, the largest to 10 cm long and to 4 or more cm wide; inflorescence a virgate thyrsus, often half as tall as the plant, sparingly glandular-pubescent; peduncles and pedicels suberect, short, subequal; cymules 2-4-flowered; calyx 4-6 mm high, the lobes narrowly to broadly ovate; corolla rose-pink, often yellowish in bud and at tube, with dark and narrow guide lines within throat, 22-30 mm long, not villous within, all the lobes reflexed; anther-sacs longer than broad; the shorter pair of fertile filaments sparingly viscid-puberulent toward base, the staminode not dilated nor bearded nor exerted.

Some correction is necessary in Brandegee's original description. The type is not "glandless" but distinctly glandular-puberulent within the inflorescence; its fragments indicate an original height of at least 6 dm, and the thyrsus varies from 3 to 4 dm; also the tube of the corolla is barely 1.5 times as long as the calyx.

KEY TO SUBSPECIES

- Corolla strongly gibbous, calceiform, the orifice oblique, the throat 12-15 mm wide pressed. ----- 7a. *P. f.* subsp. *typicus*
 Corolla gradually ampliate, the orifice perpendicular, the throat 6-10 mm wide pressed. ----- 7b. *P. f.* subsp. *Austinii*

7a. *Penstemon floridus* subsp. *typicus* nom. nov.

Penstemon floridus T. S. Brandegee, l. c.

Corolla abruptly inflated, strongly gibbous, somewhat contracted to the oblique orifice, the base of the lower lip projecting beyond that of the upper lip.

Canyons and plains in the region of the White Mountains, in Nevada and California, at elevations of 1700 to 2400 meters. Type locality: "Mt. Magruder, Nevada, *Dr. C. A. Purpus*, no. 5928."

NEVADA. Mineral Co.: base of Mt. Montgomery, near Queen Station, *Tidestrom* 10031 (Ph). Esmeralda Co.: Queen Canyon, White Mts., *Ferris* 6672 (SU); Columbus Marsh, June 17, 1927, *Jones* (Ph); Montezuma Mtn., W. of Goldfield, *Tidestrom* 9776 (US); David Davis Ranch, *Shockley* 578 (GH); Mount Magruder, *Purpus* 5928 (C, type; isotype US).

CALIFORNIA. Mono Co.: Benton, June 16, 1927, *Jones* (Ph); Crooked Creek, Owens River, *Peirson* 10730 (CI); 3.8 mi. S. of McGee Creek, between Convict Lake and Bishop, *Keck* 3881 (C,CAS,CI,Po,SU); Sherwin Hill Grade, out of Rock Creek, *Keck* 510 (CI, Kew, Ph,SU); Long Valley, between Bishop and Mammoth, 1913, *K. Brandegee* (US). Inyo Co.: Rock Creek Grade, N. of Bishop, July 28, 1926, *Klyver* (SU); 12 mi. S. of Bishop, *Benson* 6038 (CI); Oil Creek, *Austin* 187 (C); Wyman Canyon, White Mts., *Tidestrom* 9872 (Ph); Wyman Creek near Deep Springs Valley, *Ferris* 1372 (SU); Payson Canyon, *Keck* 548 (Berlin,CI,Ph,SU); Black Canyon, June 8, 1930, *Duran* (C,CAS,F,M,NY,RM,SU,US); 10 mi. N.E. of Big Pine, *Keck* 527 (CI,GH,SAna,SU); Lone Pine, July 5, 1935, *Edwards* (CI).

7b. *Penstemon floridus* subsp. *Austinii* (Eastw.) comb. nov.

Penstemon Austinii Eastw., Bull. Torr. Club 32:206, 1905.

To the southward of subsp. *typicus*, in Esmeralda and Nye counties, Nevada, and in Inyo County, California, at elevations of 1050 to 1850 meters.

NEVADA. Esmeralda Co.: Lida, June 4, 1924, Jones (NY,SU). Nye Co.: Beattie, Heller 10423 (C,CAS,GH,NY,SU,US).

CALIFORNIA. Inyo Co.: Inyo Mts., Coville & Funston 1783 (CAS,NY,SU,US); Oak Creek, July 4, 1899, S. W. Austin 187 (CAS, type); Owens Valley, Austin 187 (C, possible isotype); road from Wild Rose Canyon to Emigrant Wash, Panamint Mts., Ferris 7998 (C,C.I.M,Po,SU).

It is apparent that this species divides naturally into a northern subspecies marked by a saccate corolla with oblique limb, and a southern subspecies with a much narrower, nearly tubular corolla with erect limb. This is so although the material farthest to the north and south respectively is the most unlike, while that from the geographical center of the species is less distinct. Nevertheless, I have not had to class any collection as strictly intermediate between the subspecies.

It has not been so apparent, however, as to which names should be applied to the subspecies. Unfortunately, the types of both *P. floridus* Bdg. and *P. Austinii* Eastw. now have no good corollas, and it is only by a careful reconstruction of floral fragments and a comparison between buds and immature flowers, that I have been able to place them.

The type of *P. floridus* came from Mount Magruder, that rises just to the south of Lida, Nevada. Above, I have cited a collection from Lida under subsp. *Austinii*, marking the northernmost station for that subspecies. In this collection, the corollas are wide, but otherwise typical of the subspecies. On the other hand, the type of *P. floridus* has buds and a broken flower that match very closely those in collections from the White Mountains. The single corolla is abruptly ampliate, and Brandegee described it as being "slightly contracted at the mouth." Accordingly, the northern material becomes subsp. *typicus*.

The type of *P. Austinii* was collected at Oak Creek, Inyo Co., July 4, 1899, by S. W. Austin, no. 187. In the Herbarium of the University of California there are two sheets labelled *Austin 187*. One of these, marked Owens Valley, without date, is of the southern subspecies; the other, labelled "Oil Creek, July 4," is subsp. *typicus*. I don't know where Oil Creek is located, but I believe the Oak Creek of the type is that which runs from the Sierras to Old Camp Independence. This is definitely south of the range of subsp. *typicus*. Since this is the case and since the buds and twisted flower appear to be of the southern subspecies, and considering that Miss Eastwood described the flower as being less ventricose than that of *P. floridus*, and that she stated no. 1783 of the Death Valley Expedition was the same, I feel satisfied in applying the name *Austinii* to the narrower-flowered subspecies.

Penstemon floridus is closely related to *P. pseudospectabilis* Jones as indicated by a similarity in foliage, inflorescence, and details of the corolla and its parts. In particular, *P. floridus* subsp. *Austinii* approaches rather closely in morphology to *P. pseudospectabilis* subsp. *typicus*. The principal distinction between them is the connate-perfoliate upper cauline leaves of the latter. Further suggestive of the relationship between these species is the fact that their

most similar subspecies are those which approach geographically most closely to each other. This is possibly indicative of a direct and continuous connection in the past. At present, however, the morphological and geographical hiatus occurs between the species as here delimited rather than between the subspecies of *P. floridus*.

To the northward, *P. floridus* is also closely related to *P. rubicundus*.

8. *Penstemon pseudospectabilis* Jones

(Fig. 2)

Penstemon pseudospectabilis M. E. Jones, Contr. West. Bot. 12:66, 1908.

Stems 6-10 dm tall; leaves often moderately glaucous, thin or moderately coriaceous, finely and sharply serrate-dentate, the basal lance-ovate to broadly ovate, the lower cauline sessile or nearly so, the upper cauline connate-perfoliate, forming disks up to 12 cm long and 6 cm broad; inflorescence a virgate thyrsus, often half as tall as the plant; peduncles and pedicels suberect, \pm equal in length, cymes 2-4-flowered; calyx 4-6 mm high, the lobes mostly ovate and short-acuminate; corolla pink to rose-purple, often yellowish in bud and at tube, with dark and prominent guide lines within throat, 20-26 mm long, tubular-funnelform, the throat \pm ventricose, all the lobes spreading or reflexed; anther-sacs mostly as long as broad; filaments \pm viscid-puberulent toward base, the staminode not appreciably dilated and rarely bearded apically, included.

KEY TO SUBSPECIES

A. Pedicels and calyx glandular-pubescent.

B. Corolla-throat moderately amplate, 6-9 mm wide (pressed); inflorescence not leafy, rarely interrupted.

C. Staminode glabrous; throat not villous at lower lip; anther-sacs scarcely as long as broad.8a. *P. p.* subsp. *typicus*

CC. Staminode bearded; throat sparsely villous at lower lip; anther-sacs longer than broad.8b. *P. p.* subsp. *bicolor*

BB. Corolla-throat definitely ventricose, 9-12 mm wide; inflorescence usually leafy below, frequently interrupted by long internodes; anther-sacs as long as broad.8c. *P. p.* subsp. *Clutei*

AA. Pedicels and calyx glabrous; corolla-throat 6-9 mm wide; anther-sacs scarcely as long as broad.8d. *P. p.* subsp. *connatifolius*

8a. *Penstemon pseudospectabilis* subsp. *typicus* nom. nov.

Penstemon pseudospectabilis Jones, l. c.

Leaves relatively thin to moderately coriaceous, glaucous, serrate with prominent often caudate teeth; calyx and pedicels moderately glandular-pubescent; corolla rose-purple, scarcely inflated anteriorly, definitely viscid-puberulent within anteriorly, the lips 4-5 mm long with relatively large lobes.

An uncommon plant of the mountains from the southeastern Mohave Desert of California to the Sonoran Desert of western Pima County, Arizona. Type locality: "Chimihuevis Mts., northwestern Arizona, at 3000 feet altitude, April 23, 1903" (M. E. Jones).

CALIFORNIA. San Bernardino Co.: Sheephole Mts., Mar. 28, 1924, *Jaeger* (GH), Mar. 30, 1928, *Jaeger* (CI,SU), Apr. 28, 1928, *Jaeger* (Po); Mopas Wash, Mopas Mts. (adjacent to Turtle Mts.), *Ferris & Bacigalupi* 8201 (C,CI,SU), Riverside Co.: Corn Springs, Chuckawalla Mts., *Munz & Keck* 4909 (C,GH,NY,Po,SU); Aztec Well, Chuckawalla Mts., Mar. 1921, *Jaeger* (Ph). Imperial Co.: *Bard*, May 1919, *Westover* (Ph).

ARIZONA. Mohave Co.: Hualapai Mts., Apr. 23, 1903, *Jones* (Po); Chimehuevis Mts. (often called Mohave Mts.), Apr. 21, 1903, *Jones* (Po, type of 2 sheets; isotypes C,US). Pinal Co.: Sacaton Agency, *Gilman* 201 (CI,UAriz), 128 (UAriz); mountains near Sacaton, *Hastings & Thornber* 9093, 9094 (UAriz), *Thornber* 8184 (UAriz). Pima Co.: Ajo, Apr. 1916, *Mairs* (UAriz, the staminode is moderately bearded).

8b. *Penstemon pseudospectabilis* subsp. *bicolor* (Bdg.) comb. nov.

Penstemon Palmeri var. *bicolor* T. S. Brandegee, Univ. Calif. Publ. Bot. 6:360, 1916.

Leaves thick and coriaceous, moderately glaucous, serrate with prominent often caudate teeth; calyx and pedicels strongly glandular-pubescent; corolla rose-purple, slightly inflated anteriorly, definitely viscid-puberulent to not at all viscid within, the base of lower lip sparsely villous, the lips 4.5-7 mm long with large lobes; staminode prominently bearded with long yellow hairs.

Local in southern Clark County, Nevada. Type locality: "Good Springs, Nevada."

NEVADA. Clark Co.: Good Springs, May, 1915, *K. Brandegee* (C, type; isotypes, M,US); El Dorado Canyon, 1880, *Davis* (M), *Tidestrom* 8834 (Ph); El Dorado Canyon at Nelson, Apr. 30, 1907, *Jones* (CI,Ph,Po,SU).

The type at the University of California is represented by two sheets, the corollas on one of which are "light yellow" while they are "purple" on the other. The yellow-flowered plant I consider a random color variant of the sort to be expected in a reddish flowered species when the red-purple pigment fails to develop. Consequently, the choice of the name "bicolor" for this unit is quite inapt.

8c. *Penstemon pseudospectabilis* subsp. *Clutei* (A. Nels.) comb. nov.

Penstemon Clutei A. Nels., Amer. Botanist 33:109, 1927.

Leaves relatively coriaceous, glaucous, serrate-dentate with fine pungent teeth; calyx and pedicels lightly glandular-pubescent; corolla pink to rose, amply inflated and ventricose, definitely glandular-puberulent within, the base of lower lip sparsely villous or, when the staminode is unbearded, not villous; staminode frequently bearded for 1/3 its length, sometimes not bearded.

Local in central Coconino County, Arizona, in the region about Sunset Crater, northeast of Flagstaff. Type locality: "Collected in lava sand, July 12, 1923, Painted Desert, north of San Francisco Peaks, Arizona. Specimens [type] from plants flowered in the collector's (Willard N. Clute's) garden [in Illinois]." The type bears the additional information, "near Sunset Mountain."

ARIZONA. Coconino Co.: Grand Canyon, *MacDougal* 175 (C,GH); Sunset Mt., N. of San Francisco Peaks, *Clute* 6 (RM, type, garden-grown), ditto, July 12, 1923, *Clute* (RM, isotype, original); Sunset Crater, *Whiting* 633 (CI,Ph,RM,SU), 2346b (C,CI,SU), Sunset Peak, *Purpus* 7078 (Po).

8d. *Penstemon pseudospectabilis* subsp. *connatifolius*

(A. Nels.) comb. nov.

Penstemon connatifolius A. Nels. Amer. Jour. Bot. 18:437, 1931.

P. Crideri A. Nels., *ibid.* 23:270, 1936. "Secured by the writer in the Boyce-Thompson Arboretum and garden, near Superior, Arizona, March 21, 1930. (Type no. 11262, Rocky Mountain Herbarium.)" This locality is not a great distance from the type locality of *connatifolius*. Peculiarly, no comparison is made with that earlier proposal of the same author but one is made with the very distinct *P. spectabilis* Thurb. of coastal southern California.

Leaves relatively thin, glaucescent to bright green, serrate-dentate with fine pungent teeth; calyx and pedicels very glabrous; corolla pink to rose, narrow, the throat very gradually widening from the narrow tube, strongly glandular-puberulent within, not villous, the lips 4-5 mm long with small lobes; staminode glabrous.

Common from Mohave County to Cochise County, Arizona, eastward to Dona Ana County, New Mexico. Type locality: "On sandy dry slopes, 'Apache Trail,' Salt River Canyon, not many miles from the Roosevelt Dam, Arizona."

ARIZONA. Mohave Co.: Kingman, June 1893, *Wilson* (C), June 1884, *Lemmon* (C); foot of Hualpai Mts., Apr. 10, 1927, *Braem* (SU); Kingman to Peach Spring, May 17, 1931, *Eastwood* (CAS). ? Co.: Beal's Springs, June 1884, *Lemmon* (C). Coconino Co.: Flagstaff, *Hanson 4614* (M.R.M.); Oak Creek Canyon, June 4, 1929, *McKelvey* (CAS); Snebley Hill, near Sedona, *Goodding 14* (CI). Yavapai Co.: Montezuma Well, *Goodding 21* (CI,UAriz); Cottonwood Creek, near Prescott, *Palmer 333* (C,Ph); Verde Valley, *W. W. Jones 95* (GH); Cottonwood, Apr. 9, 1920, *W. W. Jones* (C, staminode bearded at apex); Skull Valley, Apr. 28, 1903, *Jones* (M,Ph,Po, approaching subsp. *typicus*). Maricopa Co.: Canyon Lake, *Gillespie 5564* (C,Po,SU,US); Horse Mesa Dam to Mesa, Mar. 6, 1929, *McKelvey* (CAS); summit Fish Creek Grade, *Eastwood 17360* (CAS); Fish Creek, *Eastwood 6191* (CAS). Gila Co.: Verde River, between Pine and Payson, *Eastwood 17219* (CAS, CI, GH); Payson, Apr. 1933, *Collom* (Ph); Mazatzal Mts., *Eastwood 16914* (CAS, CI); Globe, *Kearney & Peebles 9276* (Po, US); Miami, *Goodding 9* (CI); Pinal Mts., *McKelvey 4055* (CI), *2137* (GH, Ph); Mescal Mts., May 24, 1890, *Jones* (Po). Navajo Co.: Ft. Apache, *Palmer 598* (GH). ? Co.: Apache Trail, *Nelson 10314* (RM, type; isotype NY); Salt River Valley, on Apache Trail, *Nelson 11261a* (RM). Pinal Co.: Superstition Mts., *Gillespie 5513* (C,Po,SU,US), *8583* (SU,US); Superior, *Peebles 9180* (Po,US); Oracle, May 28, 1905, *Thornber* (CI,UAriz). Aug. 28, 1903, *Jones* (Po), *Peebles 6851* (CAS). Pima Co.: Santa Catalina Mts., Sabino Canyon, Apr. 11, 1902, *Thornber & Kellogg* (CI,UAriz); Camp Lowell, Apr. 13, 1881, *Pringle* (GH,M,Ph); Rincon Mts., June 19, 1884, *Pringle* (GH,Ph). Graham Co.: Eagle River, *Rusby 329* (M,Ph); Santa Teresa Mts., *Goodding 16* (CI); Camp Grant, *Palmer 160* (M); Mt. Graham, *Peebles et al. 4500* (Ph); Graham Mts., *Thornber & Shreve 8935* (UAriz); Pinaleno Mts., *Maguire et al. 10959* (Ph, Utah). Greenlee Co.: 17 mi. N. of Clifton, *Maguire et al. 11861* (Utah); Clifton, *Davidson 104* (GH). Cochise Co.: Campbell's Ranch, Azucar Mts., Apr. 15, 1931, *Jones* (C,CI,Po,SU); Dragoon, May 5, 1928, *Carler* (CI); Lowell, *Parish 182* (SU); 3 mi. E. of Hilltop, *Chiricahua Mts., Maguire et al. 11105* (Ph,Utah); head of Wood Canyon, *do., Blumer 1536* (GH,M,SU,UAriz); Cave Creek Canyon, *do., June 26-29, 1927, Kusche* (CAS); Pinery Canyon, *do., Stone 115* (Ph).

NEW MEXICO. Catron Co.: Mogollon Mts., Apr. 1880, *Greene* (M); Silver

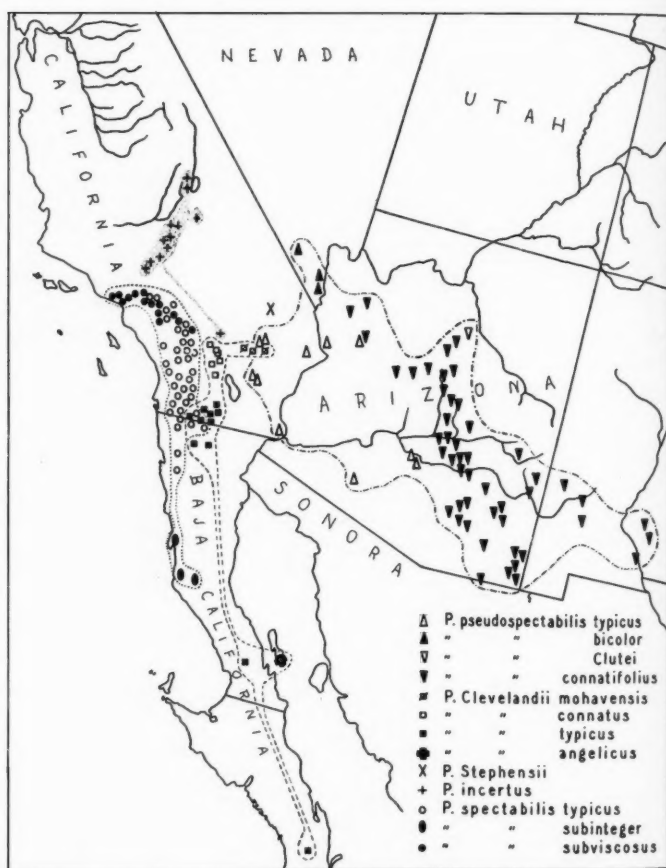


Fig. 2. Distribution of *Penstemon*, section *Pellanthra*, subsection *Spectabiles*, in part.

Creek, Gila Forest, Eggleston 16809 (Ph). ? Co.: Wright 1475 (C,GH). Grant Co.: Ft. Bayard, Mulford 631 (Ph). Dona Ana Co.: Dripping Springs, Brazito, Child 530 (M); Organ Mts., Wooton 3372 (SU), May 14, 1899, Wooton (Po), May 1900, Wooton (RM,UAriz); Valley of Rio Grande, below Donana, Parry et al. (GH).

This species appears to be decidedly natural. Subsp. *typicus* occurs to the west of and parallel to subsp. *connatifolius* and the two influence each other in northwestern Arizona and adjacent California. For instance, the type collection of *P. pseudospectabilis* and material from Mopas Wash are very similar to each other and are marked from the other collections of subsp. *typicus* by their thin leaves like those of subsp. *connatifolius*. Also, these two collections show an approach to the latter by the paucity of their glandular-pubescent in the inflorescence. Furthermore, material of subsp. *connatifolius* from Mohave County, Arizona, shows the influence of its proximity to subsp. *typicus* and *bicolor* by the increased size of its flowers. Subsp. *bicolor*, in keeping with its geographical occurrence to one side of the other subspecies, is fairly well marked by the definite beard on the staminode and lip, the prominently lipped corolla, and the long-celled anthers. In the other subspecies, however, bearding of the staminode is not a dependable character. In *Clutei* it is present or absent indiscriminately; in *typicus* and *connatifolius* it has been observed to be totally absent with single exceptions in each subspecies.

Subsp. *Clutei* is not easy to key out from subsp. *bicolor*, but there is no evidence that they are parts of one subspecies. On the contrary, it appears that *Clutei* has more in common with *connatifolius*, probably arising from it, while *bicolor* seems closely connected with *typicus*. This conclusion is based upon a consideration of the architecture of the inflorescence, flower-color, leaf-texture and -cut, and distribution.

9. *Penstemon Clevelandii* Gray

(Fig. 2)

Penstemon Clevelandii Gray, Proc. Amer. Acad. 11:94, 1876.

Stems few to several, 3-7 dm tall; leaves glaucous or deep green, entire to sharply dentate, the basal ovate, the upper cauline deltoid-lanceolate to cordate and distinct, or (in subsp. *connatus*) connate-perfoliate; thyrus narrowly racemose, 1-3 dm long, 3-6 cm broad, usually strongly anthocyanous, glabrous or glandular-pubescent; peduncles and pedicels suberect or somewhat divergent, subequal; cymules 2-8-flowered; calyx 4-6 mm high, darkly anthocyanous, the lobes ovate to suborbicular, obtuse to acuminate; corolla crimson or red-purple, without prominent guide lines, 17-24 mm long, 5-8 mm wide at throat, tubular-funnelform, the tube proper shorter than the gradually amplified throat, the quadrate lobes rotately spreading; anther-sacs explanate and glabrous (not explanate but denticulate-ciliolate in subsp. *connatus*), as broad as long; fertile filaments glabrous, the staminode scarcely dilated, bearded or glabrous apically, glabrous (rarely viscid-puberulent) basally, included.

KEY TO SUBSPECIES

- A. Upper leaves distinct; anther-sacs explanate, glabrous.
 B. Upper leaves deltoid-lanceolate to cordate; inflorescence definitely thyrsoid; staminode usually bearded.
 C. Staminode 6-8 mm long; corolla contracted at orifice, the limb not glandular within, the lower lip densely pilose at base. -----
 -----9a. *P. C. subsp. mohavensis*
 CC. Staminode 8.5-11 mm long; corolla not contracted at orifice, the limb glandular-puberulent within, the lower lip not pilose. -----
 -----9b. *P. C. subsp. typicus*
 BB. Upper leaves cuneate-obovate; inflorescence sub-racemose; staminode glabrous. -----
 -----9c. *P. C. subsp. angelicus*
 AA. Upper leaves connate-perfoliate; anther-sacs not explanate, denticulate-ciliolate. -----
 -----9d. *P. C. subsp. connatus*

9a. *Penstemon Clevelandii* subsp. *mohavensis* subsp. nov.

Foliis viridibus serrato-dentatis distinctis; pedicellis sepalisque glandulari-pubescentibus; corollis angustioribus a fauci constrictis, limbo intus non glanduloso, labio inferiore intus conspicuo barbato; stamine sterili 6-7 mm longo moderate flavo-barbato; antheris glabris explanatis.

Occasional from the Little San Bernardino Mountains to the Sheephole Mountains, along the southern edge of the Mohave Desert.

Type: *M. French Gilman*, no. A2, collected May 9, 1926, among rocks at Keyes Ranch, Little San Bernardino Mts., San Bernardino County, California, Herbarium of the University of California, no. 311289; isotypes CI, Po.

Also collected in the Little San Bernardino Mts. at Coyote Holes, Apr. 20, 1935, *Mrs. W. Egbert Schenck* (Po, somewhat glaucous); in rock crevices at Barker's Reservoir, near Keyes Ranch, in Riverside Co., May 20, 1923, *Jaeger* (CI, GH, Ph, Po); and in the Sheephole Mts., San Bernardino Co. Mar. 24, 1924, *Jaeger* (Po, staminode to 8.5 mm long!).

9b. *Penstemon Clevelandii* subsp. *typicus* nom. nov.

Penstemon Clevelandii A. Gray, l. c.

Arid canyon sides bordering the desert, from San Diego Co., California, to Comandu, Baja California. Type locality: "Cañon Tantillas in Lower California, recieved from D. Cleveland in flower, and later from Dr. Palmer in fruit."

CALIFORNIA. San Diego Co.: Yacqui Well, Apr. 5, 1932, *Epling & Robison* (C, NY, Ph, SU); Vellecito, Apr. 4, 1932, ditto (C, NY, Ph, SU) Campbell's, Vallecito Valley, *Munz & Hitchcock 12090* (C, F, M, Po); Mason's (now Mason Valley), Apr. 12, 1896, *Brandegee* (C); Aqua Caliente, Apr. 1, 1896, *Brandegee* (C); Buckmans Spring, *Munz 8083* (GH, NY, Ph, Po); Pinyon Mt.: between Campo and Hill Valley, *Abrams 3619* (C, F, GH, M, NY, SU, US); Campo (GH); 5.5 mi. E. of Campo, *Wolf 2164* (C, SU); 3 mi. W. of Jacumba, *Johansen & Ewan 7155* (CI, SU); Jacumba (US); E. of Jacumba, Feb. 28, 1924, *Jones* (NY, Po, SU). Imperial Co.: Mountain Springs Grade, *Keck 3905* (C, CI, Ph, SU).

MEXICO. Baja California: 50 mi. S.E. of Tecate, *Munz 9542* (Po,US); Cantillas Mts., July 8, 1884, *Orcutt* (C, US); Canyon Tantillas (Cantillas), May 29, 1875, *Dunn 393* (C, probably isotype), *Cleveland 306* (GH, type). In a letter to I. M. Johnston, Cleveland disclaims this locality and says the specimen was doubtless collected near Buckman's Spring; but I believe with Ewan⁴ that Cleveland doubtless sent Gray a duplicate of Dunn's collection which became the type. Same locality, 1875, *Palmer* (GH); Ubi, May 9, 1889, *Brandegee* (C); Comandu, May 1888, *Brandegee* (GH,NY).

9c. *Penstemon Clevelandii* subsp. *angelicus* (Johnst.) comb. nov.

Penstemon Clevelandii var. *angelicus* Johnst., Proc. Calif. Acad. Sci. 12:1165, 1924.

Known only from the type collection, made on a sheltered ledge of a basaltic cliff in a short, gorge-like constriction of Palm Canyon on Angel de la Guarda Island, Gulf of California, Baja California, I. M. Johnston 3413 (CAS, type; isotype US).

The type collection is in old fruit and little is known about the flowers. Nevertheless, this seems to represent at least a distinct ecotype of the species as shown by the unique shape of the upper leaves, their toothing, which is coarser than that found in subsp. *typicus*, and by the reduced inflorescence. Johnston picked up some withered blossoms beneath the plant. One of these I boiled and found to be only 15 mm long and 6 mm broad, with all filaments glabrous throughout, the anther-sacs glabrous, not peltately explanate but apparently either young or infertile, and the straight staminode, only 7.5 mm long, was moderately dilated at the apex. The tube in this corolla, as shown by the insertion of the longer fertile filaments and the staminode, is less than 3 mm long, an extreme reduction from the other subspecies, which, in turn, have a much shorter tube in proportion than has *P. Stephensii*.

Further collections will be necessary to satisfactorily explain the true status of this entity and its relationship to subsp. *typicus*, for the latter itself is known from too scattering a series of stations to be thoroughly understood.

9d. *Penstemon Clevelandii* subsp. *connatus* (M. et J.) comb. nov.

Penstemon Clevelandii var. *connatus* Munz et Johnst., Bull. Torr. Club 49:357, 1923.

Canyons bordering the western edge of the Colorado Desert, Riverside Co., California. Type locality: "near Van Deventers, southeastern base of San Jacinto Mountains, June 1901, *H. M. Hall 2149* (Univer. Calif. Herb. 54999)."

CALIFORNIA. Riverside Co.: Palm Springs, *Eastwood 2979* (CAS), *Parish 1216* (C,F,GH,Ph,SU,US); Andreas Canyon, *Johnston 1043* (Po,SU,US); Murray Canyon, Apr. 10, 1922, *Peirson* (SU); Van Deventers, *Hall 2149* (C, type; isotypes SU,US), *1160* (C,M,NY,SU); Coyote Canyon, *Hall 2766* (C,M,NY,US, in part. intermediate to subsp. *typicus*); Rockhouse Canyon, *Jaeger 227* (US); Old Nicholas Canyon, *Munz 5931* (C,NY,Po).

This species is exceptional within the section in the amount of variation

⁴ Ewan, J. Cantillas Canyon of Lower California. Amer. Midl. Nat. 18:360, 1937.

that it exhibits within a limited geographical range. The three subspecies, *mohavensis*, *connatus* and *typicus*, are based on many characters that for clarity's sake are here tabulated.

Subsp. <i>mohavensis</i>	Subsp. <i>connatus</i>	Subsp. <i>typicus</i>
Northern range.	Intermediate range.	Southern range.
Leaves bright green, strongly and coarsely serrate, the upper cauline distinct.	Leaves blue-glaucous, strongly and finely serrate, the upper connate-perfoliate.	Leaves deep green or glaucescent, entire to moderately serrate, the upper distinct.
Pedicels and calyces glandular-pubescent.	Pedicels and calyces glabrous.	Pedicels and calyces glandular - pubescent, glabrous only about Jacumba and in Baja Calif.
Corolla contracted at orifice, narrowest.	Corolla not contracted at orifice, usually broadest.	Corolla not contracted at orifice, usually intermediate.
Limb not glandular within, pilose at base of lower lip.	Limb not glandular within, glabrous or obsoletely pilose.	Limb glandular-puberulent within, not pilose.
Anthers glabrous, explanate.	Anthers ciliolate-denticulate, not explanate.	Anthers glabrous, explanate.
Staminode 6-8 mm long, bearded.	Staminode 9-10 mm long, bearded.	Staminode 8.5-11 mm long, bearded or glabrous.

This tabulation indicates that most of the characters do not follow a progressive trend from one extreme of the range to the other. It also shows that subsp. *connatus* and the subsp. *typicus* are separated by abundant characters in spite of the proximity of their ranges. It is remarkable also that there is only one locality known at present in which the characters of these subspecies intermix, namely Coyote Canyon, Riverside County.

As to the bearding of the staminode, this character is variable within subsp. *typicus*, because, when present, the beard is not heavy and, in fact, is often represented by a rudimentary growth. The beard is likewise often poorly developed in subsp. *connatus*. In certain collections of subsp. *typicus* from San Diego County the staminode is bearded or glabrous in adjacent plants, as for example in *Abrams 3619*, *Wolf 2164*, and *Keck 3905*. Accordingly, the absence of a staminodal beard in material from central Baja California (Ubi and Angel de la Guarda Id.) can scarcely be taken as a basis for a subspecies.

10. *Penstemon Stephensii* Brandegee

(Fig. 2)

Penstemon Stephensii T. S. Brandegee, *Zoe* 5:151, 1903.

P. Clevelandii var. *Stephensii* Munz et Johnst., *Bull. Torr. Club* 49:41, 1922.

Stems few to several, 6-10 dm tall; leaves thin, finely and sharply denticulate, the basal ovate-oblong, the several upper cauline pairs connate-perfoliate, forming disks 5.9 cm long, 2.5-4 cm wide; thyrsus virgate, 2-3 dm long, ca. 3 cm broad, sparingly glandular-pubescent; peduncles and pedicels erect, short; cymules 2-4 flowered; calyx 3-4 mm high, the lobes ovate-cordate,

abruptly acute; corolla flesh-color to pink-lavender, without prominent guide lines, 17-20 mm long, 4.5 mm wide at throat, sparingly glandular-puberulent, essentially tubular, the tube proper (as shown by the insertion of the longer fertile filaments and the staminode) as long as the throat, the quadrate lobes rotately spreading, 3-4 mm long; anther-sacs as broad as long; all filaments glabrous throughout, the staminode scarcely dilated, included.

An endemic species of the Providence Mountains, Mohave Desert, San Bernardino Co., California.

CALIFORNIA. San Bernardino Co.: Providence Mts., May 25, 1902, T. S. Brandege (C. type); Bonanza King Mine, Munz, Johnston & Harwood 4274 (Po,US).

In reducing this species to varietal rank under *P. Clevelandii*, Munz and Johnston stress the great similarity between it and certain collections of *P. Clevelandii* (referable to subsp. *connatus*) as regards gross aspect, size and vegetative characters. They say, "there is, however, one character which separates the two collections of *P. Stephensii* from all of the many collections of *P. Clevelandii*; this is the lack of bearding on the sterile filament. Though the corollas of the two forms are alike in size, color, and shape, the sterile filament in *P. Stephensii* is absolutely bald, while it is densely bearded in *P. Clevelandii*. Appreciating, therefore, that we are concerned here only with a unit-difference, we feel that *P. Stephensii* is nothing but a geographic race of *P. Clevelandii* and, because of it, worthy only of a subordinate rank."

I must disagree with the statement that there is but a unit difference between *P. Stephensii* and *P. Clevelandii*. A tabulation of characters will emphasize the point:

<i>Penstemon Stephensii</i> Bdg.	<i>Penstemon Clevelandii</i> Gray
Corolla flesh-colored, 4-5 mm wide, the tube equalling the scarcely at all dilated throat.	Corolla red-purple, 5-8 mm wide, the tube shorter than the obviously dilated throat.
Leaves thin, connate-perfoliate.	Leaves coriaceous, connate-perfoliate only in subsp. <i>connatus</i> .
Calyx 3-4 mm high.	Calyx 4-6 mm high.
Corolla-limb glandular-puberulent within.	Corolla-limb glandular only in subsp. <i>typicus</i> .
Anther-sacs peltately explanate and glabrous.	Anther-sacs peltately explanate (without rim) only in subsp. <i>typicus</i> and glabrous except in subsp. <i>connatus</i> .
Staminode 6-7 mm long, glabrous.	Staminode longer than 6-7 mm except in subsp. <i>mohavensis</i> , glabrous only in subsp. <i>angelicus</i> and rarely in subsp. <i>typicus</i> .

This table brings forth several qualitative differences between the two species in addition to those of a quantitative nature. The geographic hiatus between the two is 135 km. in extent, which is an indication of their isolation. Then, too, it should be noted that *P. Stephensii* apparently has more characteristics in common with *P. Clevelandii typicus*, from which it is separated by 180 km., than with the nearer subsp. *mohavensis*.

Another relationship seems very important in this connection, namely, that between *P. Stephensii* and *P. pseudospectabilis*. I believe that connection is just as close as the one between *P. Stephensii* and *P. Clevelandii*, and that *P. Stephensii* may be considered as possibly occupying an intermediate position between the other two phylogenetically. There is no experimental evidence at hand to offer a clue as to the evolutionary order between these closely related units; but *P. Stephensii* appears to have ample basis for specific standing, both morphological and geographical, and it is to be regarded as an additional example of the relict species that mark the Providence Mountains.

I support the view of Munz and Johnston in their controversy with T. S. Brandegee over the color of the flowers in this species and *P. Clevelandii*. The latter species is definitely not a scarlet-flowered penstemon, although the crimson blossoms show no obvious suggestions of blue pigment.

11. *Penstemon incertus* Brandegee

(Fig. 2)

Penstemon incertus T. S. Brandegee, Bot. Gaz. 27:454, 1899.

P. fruticiformis var. *incertus* Munz et Johnst., Bull. So. Calif. Acad. Sci. 23:33, 1924.

In habit very similar to *P. fruticiformis* Cov., usually shrubby, forming plants 5-10 dm across at base, at times (younger plants?) herbaceous quite to the narrow suffrutescent base, branching below, the herbage glabrous and glaucous, the leaves narrowly linear-lanceolate; thyrsus lax, moderately glandular-pubescent, the peduncles widely divaricate to horizontal; calyx 5-7 mm high, the lobes lance-ovate to nearly rotund, abruptly acute to short-acuminate; corolla violet with a reddish cast or purple, the limb deep blue ("pink" in one collection), without guide lines, 25-28 mm long, 8-11 mm wide, the tube (twice the length of the calyx) gradually expanding into an ample ventricose non-ribose throat, sparingly villous across base of lobes (chiefly the central lobe) of lower lip, lobes of both lips reflexed; anther-sacs divaricate, dehiscent throughout but often not through the connective, not explanate, minutely denticulate-ciliolate around the suture; the shorter pairs of fertile filaments minutely glandular-puberulent at their dilated bases; staminode well included, short, straight, moderately dilated apically, densely bearded with medium long yellow hairs for almost its entire length or sometimes sparsely bearded, glandular-pubescent only at very base.

Infrequent from the eastern base of the Sierra Nevada and Argus Mts., Inyo Co., southward to Antelope Valley with an isolated station at Warren's Well, southern Mohave Desert, California, at elevations of 800 to 2130 meters. Type locality: "Walker pass and sandy slopes of Argus mountains, California. Dr. C. A. Purpus, nos. 5351, 5346."

CALIFORNIA. Inyo Co.: Lone Pine Creek, Hall & Chandler 7201 (C, in fruit of preceding season, improbably *P. fruticiformis*); Lone Pine trail above Carrol Creek, Ferris 3775 (SU); S. of Olancha, Benson 5903 (Lyman Benson Herbarium, CI); Argus Mts., Purpus 5346 (C, GH, M, US). Kern Co.: Walker Pass, Purpus 5351 (C, type; isotypes GH, M, US), Ferris 7892 (C, CI, F, M, SU), Howell 5001 (CAS, CI, Ph); Scodie Canyon, Onyx, June 21, 1911, ? (C); Kelso Valley, 16 mi. S.S.E. of Weldon, July 8, 1911, ? (C); 9 mi. N. of Mohave, Keck & Stockwell 3280 (Berlin, C, CAS, CI, F, GH, Kew, M, NY, ND, Ph, Po, Pul, RM, SU, US, UA, Ariz, Utah); Mo-

have, *Parish 9270* (SU), *K. Brandegee* (C); Oak Creek, *Grinnell 417* (US); between Willow Springs and Tehachapi, *Abrams & McGregor 429* (GH,NY,SU,US); N. of Willow Springs, May 23, 1932, *Rowntree* (CAS); 5 mi. N. of Neenach, *Sindel 127* (Veg. Type Map Herb., Univ. Calif.). San Bernardino Co.: Warren's Well, *Gilman 41* (C,Po), *Parish 3151* (NY,SU,US).

This species bears a remarkable superficial resemblance to *P. fruticiformis* Cov. In fact, scarcely a single vegetative character other than the presence or absence of glands within the inflorescence can be suggested for the separation of the two. Noting this resemblance and considering that the distinctions between the two consisted principally of unstable vegetative differences, Munz and Johnston⁵ reduced *P. incertus* to a variety of *P. fruticiformis*. That such action obscures the true phylogenetic status of the two species seems obvious from a consideration of the numerous floral differences between them, many of these being qualitative, which not only separate the units distinctly, but indicate that the two had very different origins.

Width of leaves, and shape, length and margins of sepals, which were stressed by Brandegee and, in turn, by Munz and Johnston, I find not even of secondary importance in the separation of these species; because the width of leaves is not at all constant in *P. fruticiformis*, while the sepal characters show every variation in *P. incertus*. In fact, Munz and Johnston pointed this out. But many floral characters there are which may be summarized as follows:

Penstemon fruticiformis Cov.

Penstemon incertus Bdg.

Corolla:

Short and broad.

Longer and narrower.

Throat abruptly flaring from short tube.

Throat gradually ventricose from long tube.

Ratio of lengths of limb to throat to tube approximately 10 : 10 : 4.

Ratio of lengths of limb to throat to tube approximately 10 : 10 : 8.

Pale lavender to pink, with darker guide lines within.

Blue-purple, without guide lines.

Glabrous without (except in subsp. *amargosae*), strongly villous at base of lower lip.

Prominently glandular-pubescent without, lightly villous at base of lower-lip.

Anthers:

Glabrous.

Denticulate-ciliate at suture.

Explanate.

Not explanate (at times not dehiscent through the connective).

Widely divaricate.

Less divaricate.

Staminode:

Prominently exerted (15-18 mm long), curved at apex.

Well included (10-12 mm long), straight at apex.

Bearded 1/3 its length with long shaggy hairs, strongly glandular-pubescent basally.

Bearded almost throughout with considerably shorter hairs or beard vestigial, scarcely glandular basally.

⁵ Bull. So. Calif. Acad. Sci. 23:33, 1924.

The first four corolla characters, as well as those listed for the anthers and staminode, definitely link *P. fruticiformis* with *P. Palmeri*, *P. Grinnellii*, and their nearest affinities. The same characters just as definitely relate *P. incertus* to *P. spectabilis*, which I regard as belonging morphologically (and phylogenetically) at the opposite end of the subsection from *P. Palmeri*.

The suites of herbarium material I have examined show no evidence of hybridization between the species. The "intergrades" that were a concern to Munz and Johnston are vegetative variations such as are found within each species.

The almost identical habit and foliage of the two species are unique in this section and strongly suggest that they are due to genes the species share in common and which they have obtained either by an early mixing of the lines or through their monophyletic origin, rather than as a result of parallel variation. The homologous characters are preserved doubtless because the species occupy similar habitats and hence are subject to the same environmental influences.

12. *Penstemon spectabilis* Thurb. ex Gray

(Fig. 2)

Penstemon spectabilis Thurb. ex Gray, Pacif. Rail. Rep. 4:119, 1856.

Stems 8-12 dm tall; leaves usually coarsely serrate, the lower broadly oblanceolate to ovate, 4-10 cm long, 2-5 cm broad, the upper connate-perfoliate; inflorescence thyrsoid or paniculate, often half as tall as the plant; peduncles divaricate, 1-3 cm long, bearing 1-5 or more pedicels as long; sepals 4-7 mm long, lance-ovate to orbicular; corolla lavender-purple with blue lobes, whitish within, or often reddish purple toward the tube, 25-33 mm long, tubular-funnelform, the throat ventricose, 9-12 mm wide; limb strongly bilabiate, the upper lip nearly erect, the lower lip reflexed, sometimes feebly bearded at orifice; anther-sacs twice as long as wide, not explanate, confluent, scabro-ciliolate, otherwise glabrous; fertile filaments dilated toward base, together with the staminode viscid-puberulent (or often merely viscid) toward base, the staminode otherwise glabrous (except in subsp. *subinteger*).

KEY TO SUBSPECIES

Pedicels and calyx entirely glabrous.

Leaves more or less coarsely serrate; staminode glabrous. -----
-----12a. *P. s.* subsp. *typicus*

Leaves entire or essentially so; staminode bearded.-----12b. *P. s.* subsp. *subinteger*
Pedicels and calyx glandular-puberulent; leaves serrate; staminode glabrous. -----

-----12c. *P. s.* subsp. *subviscosus*

12a. *Penstemon spectabilis* subsp. *typicus* nom. nov.

Penstemon spectabilis Thurb. ex Gray, l. c.

Herbage glabrous throughout; leaves, at least all those below the inflorescence, \pm coarsely serrate.

Cismontane slopes from eastern Los Angeles County, California, southward to northern Baja California, at elevations of 185 to 1,400 m. Type locality: San Pasqual, San Diego County, California, acc. to Thurber's specimens in Gray Herbarium. Gray, however, in describing the species, included New Mexican and Arizonan material with the Californian and gave a composite description of *P. spectabilis* Thurber and *P. pseudospectabilis* Jones. He cited first a sheet referable to the latter species from San Francisco Mountain, N. Mex. It is highly desirable, however, to follow the lead of Munz and Johnston⁶ and accept the Thurber specimen at Gray Herbarium as the type, thus properly applying Thurber's name and likewise avoiding considerable confusion that would follow the application of the name to the New Mexican plant.

CALIFORNIA. Los Angeles Co.: Echo Mountain, *Grant* 2453 in part (SU); San Gabriel Canyon, *Eastwood* 8952 (CAS); Claremont, May 21, 1926, *Jones* (CAS, SU); Swartout Valley, May 16, 1931, *Epling, Dunn & Goen* (C,US); San Bernardino Co.: Upland, *Howell* 2474 (CAS); San Bernardino, *Parish* 111 (C,SU,US); Reche Canyon, May 17, 1899, *Hall* (C); Redlands, *Greata* 445 (CAS). Riverside Co.: Riverside, *Hall* 2923 (C,Po,SU,US); Nuevo, May 1894, *Brandegee* (C,US); MacMullin Trail, San Jacinto Mts., June 1921, *Jaeger* (Po); Chalk Hill, San Jacinto Mts., *Hall* 2069 (C,US); Pipe Creek, Hemet Valley, *Munz* 5796 (Po); mouth, San Jacinto River Canyon, *Jenkins & Street* 1936 (Po,SU); Coyote Canyon, El Toro Mt., *Hall* 954, 1893 (C); Elsinore, May 20, 1900, *Abrams* (Po,SU); Santiago Canyon, June 1891, *Blasdale* (C); Santiago Peak Trail, *Howell* 6603 (CAS), *Munz* 7063 (Po). Orange Co.: Santiago Peak, *Abrams* 1842 (Po,SU). San Diego Co.: Fallbrook, Apr. 3, 1881, *Cleveland* (C); Pala, Apr. 19, 1925, *Hill* (Po); Bonsall, June 4, 1927, *Tose* (CAS); Palomar, May 29, 1901, *Hall* (C); 10 mi. N.W. of Warner Hot Springs, *Fosberg* 8449 (C), *Howell* 4816 (CAS); Warner Hot Springs, 1911, *Coombs* (CAS); Escondido, *Meyer* 130 (C); Lake Hodges Grove, *Wolf* 1986 (C,SU); San Pasqual, *Thurber* (GH, type), *Chandler* 5503 (SU); Santa Ysabel, May 26, 1893, *Henshaw* (US); Julian, *Hall* 1204 (C); Vallecito Canyon, Laguna Mts., *Munz* 9713 (C); Ramona, *Collins & Kempton* 161 (US); Santa Maria Valley, 5.5 mi. S.W. of Ramona, *Wolf* 2218 (CAS,SU); Descanso, June 20, 1932, *Epling et al.* (C,SU); Viejas Grade, *Griscom* 41 (C); Dehesa, *Spencer* 121 (Po); Alpine, *Grant* 6898 (SU); Mission Hills, San Diego, *Abrams* 3408 (Po,SU,US); Jamul, *Stockwell* 1244 (C,C,I,SU); Dulzura, *Spencer* 121 (C,US, staminode bearded); between Campo and Potrero, *Abrams* 3720 (SU); 1 mi. W. of Campo, *Stockwell* 1260 (CAS,C,I); 4.5 mi. E. of Campo, *Wolf* 2160 (C,SU); 4 mi. W. of Life Oak Springs, *Gander* 1862 (CI); Hipass, *Gander* 1866 (CI); W. of Jacumba, *Meyer* 435 (C); Jacumba Hot Springs, *Schoenefeldt* 3348 (SU,US).

BAJA CALIFORNIA. Tecate River, *Mearns & Schoenefeldt* 3748 (SU); Tecate, *Fosberg* 974 (SU); Nachoguero Valley, *Mearns* 3391 (SU); 5-6 mi. E. of Ensenada, *Wiggins & Gillespie* 4031 (SU); 11 mi. S.E. of Ensenada, July 26, 1928, *Jaeger* (CI).

12b. *Penstemon spectabilis* subsp. *subinteger* subsp. nov.

Omnino glaberrima (corollis glandulari-pubescentibus); foliis plerumque integerrimis vel minutissime serrulatis plus minusve undulatis; filamento sterili barbato; ceteroqui subsp. typicae similis.

Type: *Ira L. Wiggins*, no. 5207, Dudley Herbarium of Stanford University, no. 244447, collected on the Santa Maria Plains, 15 miles south of Ham-

⁶ Bull. So. Calif. Acad. Sci. 23:37, 1924.

ilton Ranch, Baja California, April 8, 1931; isotypes C,CAS,CI,F,GH,Kew, M,NY,Ph,Po,RM,US,UMichigan. This collection bears the note: "Plants 2-3 feet high; corolla bluish at lips, throat and tube with less blue than red."

Additional collections studied, all from Baja California, include *Ferris* 8539 (CI,Po,SU), from a spring 19 miles east of Rosario, on the San Augustine road, at 380 m. elevation, where it was said to be "common in wash"; *Shreve* 6441 (Desert Laboratory of Carnegie Institution, Tucson), same station; Las Huevitas (just east of Rosario), May 19, 1888, T. S. Brandegee (C, in old fruit).

12c. *Penstemon spectabilis* subsp. *subviscosus* subsp. nov.

A subsp. typica pedicellis calycibusque glandulari-pubescentibus differt.

The common form in California from the Liebre and Santa Monica mountains southeastward to the outwash fans of the San Gabriel and San Bernardino mountains where it occurs often together with subsp. *typicus*.

Type: *Philip A. Munz*, no. 2258, May 16, 1918, in wash, Claremont, Los Angeles County, Calif., Herbarium of Pomona College, no. 4216.

CALIFORNIA. San Luis Obispo Co.: Santa Inez Canyon, July 20, 1898, *Barber* (C; probably introduced). Los Angeles Co.: West Fork Garapito Creek, *Ewan* 4200 (CI); Mandeville Canyon, *Clokey & Templeton* 4475 (Po,US); Mulholland Drive, *Thackery* 257 (US); Franklin Canyon, *Thackery* 325 (US); Vermont Canyon, Griffith Park, *Howell* 3478 (CAS); Laurel Canyon, *Eastwood* 128 (CAS); Sister Elsie Peak Trail, June 10, 1916, *Grinnell* (CAS); Eagle Rock Canyon, *Braunton* 581 (US); Mount Lowe, *Grant* 930 (US); Echo Mountain, *Grant* 2453, in part (SU); Sierra Madre, *Abrams* 2618 (C,Po,SU,US); Santa Anita Canyon, *Howell* 3785 (CAS); San Gabriel, *Brewer* 162 (US); Arcadia, *Grant* 4594 (SU,US); Azusa, May 1889, *Oliver* (SU); Glendora, *Braunton* 806 (C); Claremont, *Baker* 3348 (C,Po,US). San Bernardino Co.: Lytle Creek Canyon, *Hall* 1422 (SU, intermediate to *typicus*); San Bernardino, *Parish* 4717 (Po,SU); Clark's, San Bernardino Mts., July 19, 1900, *Jones* (Po); Live Oak Canyon near Redlands, May 1923, *Billings* (SU); Forest Home, July 1928, *Van Dyke* (CAS).

NATURAL HYBRIDS

× *Penstemon Parishii* (*P. centranthifolius* × *spectabilis*) comb. nov.

Penstemon Parishii Gray, Proc. Amer. Acad. 17:228, 1882.

P. spectabilis var. *Gilmanii*, Jeps., Man. Fl. Pl. Calif. 912, 1925. "Mt. San Jacinto (M. F. Gilman 744, type)."

Habit of *centranthifolius*; herbage glaucescent and glabrous throughout; leaves linear-lanceolate to broadly ovate, entire to shallowly serrate, the uppermost usually auriculate-clasping but distinct; inflorescence a crowded virgate thyrsus scarcely more open than that of *centranthifolius*; corolla 25-30 mm long, the tube (twice the length of the calyx) gradually expanding into an ample throat 6-9 mm wide, the limb (with relatively short lobes) obscurely bilabiate, glabrous or minutely viscid-puberulent without, glabrous within, red-purple; anther-sacs longer than broad, opposite, tortuously explanate, the central partition in each sac prominent; staminode glabrous.

Not uncommon in the region where the two parents occur together, on cismontane slopes and washes from Los Angeles County to San Diego County, California. "S. E. California, in the Cucamonga Mountains and elsewhere, *Wallace* (panicles only, referred in Syn. Fl. 265, to *P. Clevelandii*), S. B. & W. F. Parish."

CALIFORNIA. Los Angeles Co.: Azusa, May 1883, *Oliver* (SU); San Gabriel Canyon, *Eastwood* 9004 (CAS); Claremont, May 5, 1897, *Chandler* (C). San Bernardino Co.: Cucamonga, *Wallace* (GH, cotype); Cucamonga Mts., S. B. & W. F. Parish 335 (C, US, isotypes); N. of Rialto, Apr. 9, 1905, *Wilder* (C); Cajon Station, *Johnston* 2308 (Po); San Bernardino, *Parish* 3644 (C); Reche Canyon, *Parish* 8032 (CAS, SU). Riverside Co.: Banning, *Jaeger* (Po); Stratton's Ranch, head of MacMullen Trail, San Jacinto Mts., June 9, 1921, *Jaeger* (SU); Mt. San Jacinto, *Gilman* 744 (Jepson Hb., fide Munz); San Jacinto River, *Hall* 567 (C). San Diego Co.: Palomar Mt., May 15, 1935, *Wys* (S. Diego Soc. Nat. Hist.); Warner Hot Springs, May 14, 1911, *Coombs* (CAS); Mason's (now Mason Valley), Apr. 1896, *Brandegee* (C); Green Valley Falls, *Gander* 211 (S. Diego Soc. Nat. Hist.); 4 mi. W. of Live Oak Spring, *Gander* 1863 (CI); Hipass, *Gander* 1865 (CI); Campo, July 4, 1884, *Cleveland* (C).

Hall (Univ. Calif. Publ. Bot. 1:119, 1902) originally suggested the hybrid origin of *P. Parishii*. This has since been confirmed in the garden. Theodore Payne has observed it on at least three occasions to arise spontaneously in gardens where *spectabilis* and *centranthifolius* were growing together. Carl B. Wolf reports the same spontaneous occurrence of the hybrid at Rancho Santa Ana Botanic Garden.

In herbaria, this hybrid is sometimes confused with *P. Clevelandii typicus*, for the ranges of the two overlap and poor specimens of the one might easily be mistaken for the other. But in *Clevelandii typicus* the corollas are shorter and narrower, the inflorescence is usually glandular-pubescent, and the anthers are peltately explanate and at least as broad as long.

× *Penstemon dubium* (*P. centranthifolius* × *Grinnellii*) comb. nov.

Penstemon dubium Davidson, Bull. So. Calif. Acad. Sci. 28:6, 1929.

Habit of *centranthifolius*, glabrous and glaucous below; leaves relatively small, widely divaricate, finely serrate, distinct; inflorescence a glandular-puberulent virgate thyrsus slightly more open than that of *centranthifolius*; corolla "magenta," 22-24 mm long, the tube (twice the length of the calyx) gradually expanding into a ventricose throat 6-7 mm wide, the limb bilabiate, the lower lip prominently marked with guide lines; anthers peltately explanate; staminode bearded for 3 mm from apex, included.

Known only from the type collection, made by Robert Kessler, in 1928, on the fire-break over Mount Lowe, San Gabriel Mts., Los Angeles Co., Calif. (Davidson Herb. no. 3659, Los Angeles Museum). Said to grow "in fair abundance amid specimens of *P. centranthifolius* and *P. Grinnellii* and suspected to be a hybrid between these two species." The type combines the characters of its two parents to such a degree as to leave no doubt as to its hybrid nature. I judge from its meager foliage that this hybrid is perhaps a less successful combination than × *P. Parishii*, and probably, for that reason, of less interest to the horticulturists.

× *Penstemon Bryantae* (*P. Palmeri* × *spectabilis*) hybr. nov.

Habit of *P. spectabilis*, ca. 12 dm tall; herbage green; leaves denticulate, the uppermost connate-perfoliate; thyrsus paniculate like *spectabilis*; calyces (and less strongly the pedicels and peduncles) glandular-pubescent; corolla pale without, deeper lavender within, the limb blue-violet, the lower lip somewhat pilose and prominently marked with guide lines, viscid without and within, 24-26 mm long, the strongly inflated throat 10-13 mm wide, the tube almost twice the length of the calyx, the limb ringent (so in corolla-shape the hybrid is intermediate between the parents); anther-sacs twice as long as broad, opposite, fully dehiscent but not explanate; staminode long-bearded apically, exerted, uncinat. — Calyce dense glanduloso-puberulo; corolla pallide lilacina, venis intus purpureis, tubo angusto, fauce subito valde ampliata campanulata; loculis antherarum oppositis oblongis nec explanatis; staminodio exserto longitudinaliter longe barbato.

Two plants of this hybrid appeared as volunteers at Rancho Santa Ana Botanic Garden, Santa Ana Canyon, Orange Co., Calif., in 1935, where plants of *P. Palmeri typicus*, from eastern Mohave Desert, were growing near plants of the endemic *P. spectabilis*. Dr. Carl Wolf, botanist at the Garden, harvested seed from these plants from which several hundred seedlings were grown. He has kindly supplied me with material and notes, and states that this hybrid seems to be of horticultural merit. Accordingly, with his permission, I am happy to assign it a name in honor of Mrs. Susanna Bixby Bryant, Managing Director and founder of Rancho Santa Ana Botanic Garden.

The type is the specimen on file in the herbarium at Rancho Santa Ana Botanic Garden; there is an isotype at the Carnegie Institution.

× *Penstemon Peirsonii* (*P. Grinnellii* × *speciosus*) comb. nov.

Penstemon Peirsonii Munz et Johnst., Bull. Torr. Club 52:225, 1925.

Stems decumbent, 3 dm high; leaves glaucescent, denticulate, upper cauline lanceolate, subamplexicaule; thyrsus narrow; calyx puberulent; corolla ca. 25 mm long, 7-8 mm wide, purplish lavender, gradually ampliate, glabrous; anther-sacs oblong, divergent, dehiscent throughout but not peltately explanate; staminode yellow-bearded.

Known but from a single individual, collected on a dry slope along Seymour Creek, Mt. Pinos, Ventura Co., Calif., at 5900 ft. elevation, June 16, 1923, by Philip A. Munz, no. 6999. (Po).

I concur with Munz' most recent opinion⁷ that this is most probably a hybrid of the parentage stated. Both supposed parents occur in the vicinity of the type locality and the characters of *P. Peirsonii* are a combination of those of these two species. Were *P. incertus* involved in the parentage, as at one time proposed, we should expect a plant with glandular calyx and corolla. Furthermore, that species does not occur on Mt. Pinos any more than does *P. heterophyllus*, which likewise has been suggested as a parent.

⁷ Munz, P. A. Man. So. Calif. Bot. 469, 1935.

SUBSECTION III. CENTRANTHIFOLII

Stems erect, strict, herbaceous throughout, the herbage mostly glabrous and glaucous; leaves coriaceous, entire, the basal petiolate (the petiole usually winged), the cauline sessile or connate, the floral abruptly reduced; inflorescence narrowly thyrsoid or subracemose; corolla tubular, reddish, obscurely bilabiate; stamens mostly included; anther-sacs mostly peltately explanate and glabrous. Evidently pollinated by humming birds. Based upon *P. centranthifolius* Benth.

The six species treated in this account show their phylogenetic unity not only in the continuity of their variations, but in the unique features of the staminode, including its uncinate apex (except in *Parryi*) and peculiar beard of stubby, flattened hairs, which is well developed in *Parryi* but occurs in vestigial form in at least some collections of *centranthifolius*, *subulatus*, *utahensis* and *confusus*. These features of the staminode, together with the distribution of glands in the corolla and corolla-shape, link certain of these species with members of the *Spectabiles* and emphasize the unity of the section *Peltanthera*.

The subsection *Centranthifolii* is remarkable not only in that its members transcend the ordinarily distinct color barrier between the scarlet-flowered and the purple-flowered penstemons, but that the transition is so gradual as to raise difficulties in the drawing of specific lines. The flowers of *P. centranthifolius*, of the California coastal region, are a brilliant scarlet and this species is regularly pollinated by humming birds. Likewise, the flowers of *P. subulatus*, of Arizona, are of the same bright hue, and the particularly narrow corolla-tube of this species is peculiarly fitted for pollination by hummers.

Miss Alice Eastwood has described the flower-color of *P. utahensis* as carmine and, by verbal communication with me, has supplemented that description by the term "rose red." She informs me that the flower-color of the type collection was not comparable at all to the scarlet of *P. subulatus*. Much of the material that I classify as *P. utahensis* does not lose all its color in drying but retains a degree of vermilion-red not unlike scarlet. Incidentally, *P. utahensis* has guide lines of deeper color in the throat of the corolla that are not found in *P. centranthifolius* and *P. subulatus*.

Apparently the reddish flowers of *P. confusus* always contain an underlying blue pigment that may be quite masked in some cases. Its flowers regularly fade blackish, but remnants of carmine coloring remain and blue-purple areas usually show on the dried blossoms. I have not seen fresh material from Utah, where the type was described by Jones as "red, lobes in dried specimens blue with a purple sheen." This description of color was possibly what caused Pennell (Contr. U. S. Nat. Herb. 20:337, 1920), who supposed the color was always red, to declare that Jones' description of *P. confusus* was "composite, of this red-flowered plant [*P. utahensis*] and of the blue-flowered *P. pachyphyllus* A. Gray." Going over Jones' description with his type before me, I find no evidence that he drew a composite description.

My field experience with *P. confusus* is limited to observations on subsp.

typicus in White Pine County, Nevada, and to more extensive studies of subsp. *patens* in California. My field notes indicate that the flower-color was much alike at the well separated stations, and in both cases I was impressed by the rose and lavender tints, rather than by the reds. The shades were unusual in *Penstemon*, however, with no unadulterated blue in them.

The most difficult question to decide is how to distinguish in herbarium material, which blackens, between *P. utahensis* and *P. confusus*, when their best segregating character in the field is flower-color. Other differences are of a subtle sort requiring familiarity with considerable material before their use is satisfactory. Morphological trends that develop within one species frequently are carried over in minor degree to the other. For instance, the unique papillose beard of the staminode in *P. confusus* appears in vestigial form in some material of *P. utahensis* both from San Rafael Swell, Utah, and Charleston Mountains, Nevada. Similarly, corolla-shape and corolla-size are not wholly dependable characters in themselves, but must be applied in conjunction with characters of anther and color.

It is possible that in Utah the two species may be very difficult to distinguish, but no taxonomist will assert, or has ever suggested, that the lilac-pink-flowered *P. confusus* subsp. *patens* of Inyo County has the least claim to conspecific relationship with the bright crimson *P. utahensis* (*P. subulatus* of California authors) of eastern San Bernardino County, California. Nevertheless, these exceedingly different extremes connect with their respective Utah representatives through continuous series of variations.

HETEROSTYLY

A peculiar sort of heterostyly appears in *P. utahensis* Eastw. and in *P. subulatus* Jones. This concerns three distinct lengths of style, but unlike the usual cases of heterostyly, the stamens do not undergo corresponding changes. In these two species the anther pairs of the fertile stamens are usually well separated, often for a distance approaching one-third the length of the corollatube. The style has been observed to be either half as long or as long as the shorter pair of fertile stamens, or it equals the longer pair. The latter condition is the least frequent, so far as observed, the other two occurring about equally; but only one type appears on an individual plant, indicating that this is a hereditary rather than a developmental phenomenon. Of what significance this can be in the mode of pollination of these plants is unknown. So far as I am aware this is the first recorded observation of heterostyly in *Penstemon*.

13. *Penstemon cerrosensis* Kellogg

(Fig. 3)

Penstemon cerrosensis Kell., *Hesperian* 3:481, 1860, the illustration labelled "*Penstemon Cerrosiana* Kellogg. Humming Bird's Dinner-horn."; *Proc. Calif. Acad. Sci.* 2:19, (1859) 1865.

P. brevilabris Gray, *Proc. Amer. Acad.* 17:229, 1882. "*Cerros Island, Lower California, S. Belding, 1881.*"

P. cedrosensis of Greene, *Pittonia* 1:206, 1888, and the majority of succeeding authors. Since Cedros Island was known on the earlier maps and to writers

in English as Cerros Island, even though erroneously so, the spelling employed by Kellogg was intentional and is not subject to correction.

Suffrutescent and branching at base, stems few, or reduced to 1, 1.5-4.5 dm tall, the herbage glabrous, glaucous; leaves crowded toward base of stem, at length reflexed, the lower cauline lance-oblong, acute, petiolate, the upper cauline lanceolate, acuminate, \pm auriculate clasping, 3-7 cm long, 8-14 mm wide; inflorescence a leafy narrow thyrus, lightly glandular-pubescent; calyx 5-7 mm high, the lobes narrowly lanceolate, the margin narrowly scarious; corolla 12-15 mm long, ca. 5 mm broad, scarlet, glandular-pubescent without, glabrous within, the throat moderately ampliate, abruptly contracted at limb, the very short lobes erect; staminode scarcely dilated, glabrous.

Known only from Cedros Island, just off the west coast of Baja California, where it is said to be very common in canyons. There is no statement regarding the type, but the original description appeared in a paper read by Dr. Kellogg before the California Academy on "new genera and species of plants found by Dr. John A. Veatch, at Cerros Island."

BAJA CALIFORNIA. Cedros Island: *J. A. Veatch* (CAS, type; isotype GH); Apr. 29, 1885, *Greene* (CAS); 1881, *Belding* (GH, type of *P. brevilabris*); north end. *Mason 2021* (CAS, GH, NY, US); high parts, abundant, *Solis 34* (US); *Rose 16139* (NY, US); *E. Palmer 739* (C, GH, NY, Ph, US); *Anthony 301* (C, GH, SU, US), 87 (C); Apr. 1, 1897, *Brandegee* (C).

14. *Penstemon centranthifolius* Bentham (Fig. 3)

Penstemon centranthifolius Benth., Scroph. Ind. Introd. 7, 1835.

Chelone centranthifolia Benth., Trans. Hort. Soc. Lond. n. ser. 1:481, 1835.

Glabrous and glaucous; stems several, 3-12 dm tall, virgate; basal leaves spatulate, petiolate, the cauline linear-lanceolate to ovate-lanceolate, the upper pairs often auriculate-clasping, rounded to acuminate at apex, \pm apiculate, 4-10 cm long, 10-30 mm wide; inflorescence a virgate thyrus half as tall as the stem; peduncles closely erect, 1-5-flowered; calyx 3-6 mm high, the lobes ovate to orbicular, abruptly acute, the margin broadly scarious, entire to erose; corolla 25-33 mm long, 4.5-6 mm broad, scarlet, tubular, the lobes scarcely spreading, glabrous without and within; anther-sacs peltately explanate; staminode glabrous.

This handsome species, the Scarlet Bugler, is well known in the coastal region from Lake County, California, to the Sierra San Pedro Martir, Baja California, and consequently the citation of its numerous collections is considerably curtailed. The plant is uncommon north of Monterey County and south of San Diego County, as shown in Figure 3, and it frequents sandy washes and light soils in open places at elevations of 10 to 1200 meters. The type was collected in "Nova California" by David Douglas.

CALIFORNIA. Lake Co.: Clear Lake Highlands; Lucerne, Williams—Lower Lake intersection. Yolo Co.: Buckeye Creek, *Ferris 715* (SU); near Hershey. Solano Co.: Gates Canyon, near Vacaville, *Heller & Brown 5387*. Contra Costa Co.: Antioch, *Heller 8895*, *Baker 2938*, *Rose 36158*. San Benito Co.: 6 mi. E. of Panoche; New

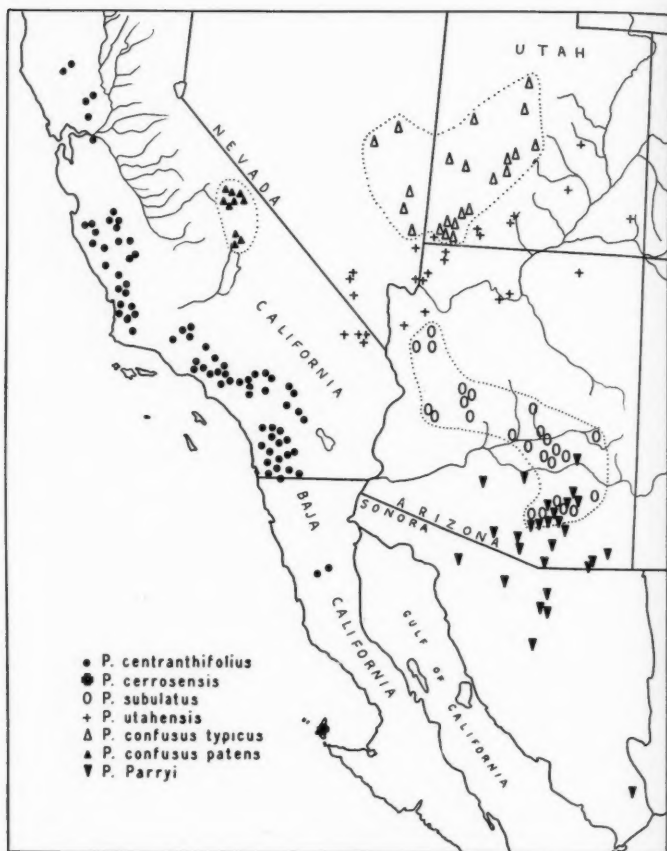


Fig. 3. Distribution of *Penstemon*, section *Pellanthra*, subsection *Centranthifolii*, in part.

Idria; Hernandez; Clear Creek (SU). Monterey Co.: abundant in Santa Lucia Mts.; Carmel Valley; Stone Canyon Coal Mine (C); Coalinga to Parkfield (C). San Luis Obispo Co.: Templeton; Arroyo Grande; Santa Margarita; Nipomo; S. of Oceano. Kern Co.: Cuyama Valley. Fresno Co.: Warthan, Eastwood (SU). Santa Barbara Co.: Sisquoc River. Kern Co.: Fort Tejon, Benson (C,SU); Llano Verde, Davy 2566 (C). Ventura Co.: Frazier Borax Mine, Mt. Pinos, Abrams & McGregor 210 (SU). Los Angeles Co.: Chatsworth Park, Abrams 1340 (SU); Malibu Hills; Liebre Mts.; Redrock Mt.; Acton, Elmer 3606 (C,SU); San Fernando; Mt. Lowe; Barley Flats; Verdugo Hills; Laurel Canyon; Rubio Wash; Glendora. San Bernardino Co.: Lytle Creek; Cajon Pass; mouth of Deep Creek; Colton; Warren's Well, T. S. Brandegee (C). Riverside Co.: Covington Ranch, Morongo Pass, Munz & Johnston 5195 (C,Po); San Jacinto Mts.; Santa Rosa, Munz 5847 (C,Po); Coyote Canyon. San Diego Co.: abundant inland and west of the desert; head of San Felipe Canyon, Yates 5469 (C).

MEXICO. Baja California: San Pedro Martir, 1893, T. S. Brandegee (C); foothills 25 mi. E. of San Telmo, Meling 18 (SU).

Several collections have been made of the yellow color form that this scarlet-flowered plant sometimes segregates.

15. *Penstemon subulatus* Jones

(Fig. 3)

Penstemon subulatus Jones, Contr. West. Bot. 12:63, 1908.

Glabrous throughout; stems few to several, 2-7 dm tall, virgate; leaves green or glaucescent, the basal narrowly linear-oblancoate to broadly oblanceolate or even elliptic, blunt, tapering to a short winged petiole, the cauline linear-lanceolate to linear-subulate, often long attenuate, not auriculate at the clasping base, 4-8 (-12) cm long, 2-8 mm wide, the basal to 12 mm wide; inflorescence a virgate elongated thyrsus similar to that in *P. centranthifolius*; calyx 3-5 mm high, the lobes ovate, abruptly acute to acuminate or subulate, very glabrous or sparingly adorned with minute sessile scurfy glands particularly on the scarious essentially entire margin; corolla 18-26 mm long, 3-5 mm broad, scarlet, tubular, the lobes moderately spreading, glabrous without and within; anthers peltately explanate; staminode not dilated, glabrous or rarely bearing minute rudiments of an apical beard, sometimes uncinat near apex.

Not uncommon on stony hillsides, canyons and mesas of central Arizona from central Mohave County to western Graham County, at elevations of 500 to 1200 m. "The type is from Hackberry, Arizona, April 25, 1903 [Jones]."

ARIZONA. Mohave Co.: Hackberry, Apr. 25, 1903, Jones (Po, type, 2 sheets; isotypes C,CAS); canyon above Antler, vicinity of Kingman, Apr. 8, 1928, Braem (SU); Hualapai Spring, Apr. 11, 1896, Orcutt (C). Yuma Co.: Harcuvar Mts., S. of Cunningham Pass, Keck 4303 (C,Ci,Ph,Po,SU,US); Cunningham Pass, Keck 4315 (Ci,Ph,SU). Yavapai Co.: Mt. View Point, between Prescott and Wickenburg, McKelvey 2547 (Ci,Ph); Hillside, May 1, 1903, Jones (Po); Congress Junction, Mar. 18, 1926, Thachery (US). Maricopa Co.: Wickenburg, May 5, 1903, Jones (Po), Palmer 633 (GH,NY); near Camp Creek, Peebles et al. 5112 (US); Tortilla Flat, Abrams 13019 (SU). Gila Co.: Ox-bow hill on way to Payson, Eastwood 17525 (CAS,Ci,Po); Roosevelt Dam, Eastwood 6294 (CAS); Globe to Roosevelt, Eastwood 17000 (CAS,Ci,SU); Globe, Treahle (Po); 5 mi. N. of Coolidge Dam, Maguire et al. 10515 (Ci). Pinal Co.: Arnett Canyon, 4 mi. S. of Superior, Gillespie

5417 (C,SU,US); between Superior and Kelvin, *Peebles et al.* 5163 (Ph); Camp Grant, *Palmer* 159 (GH); Oracle, *Thornber* 5881 (CI,UAriz); foothills of Santa Catalina Mts., *Peebles* 6870 (CAS). Pima Co.: Redington, 1913, *Kilgour* (CI,UAriz); Tucson, *Lemmon* 187 (GH); foothills W. of Tucson, *Thornber* 4485 (UAriz). Graham Co.: 5 mi. E. of Agency, San Carlos Indian Reservation, *Maguire et al.* 10357 (CI,Ph).

16. *Penstemon utahensis* Eastwood

(Fig. 3)

Penstemon utahensis Eastwood, *Zoe* 4:124, 1893.

P. Eastwoodiae Heller, *Muhlenbergia* 1:4, 1900. New name for *P. utahensis* Eastw., not *P. glaber* var. *utahensis* S. Wats., 1871.

P. subulatus of California authors as regards material from eastern Mohave Desert.

Stems several, 3-6 dm tall, glabrous, virgate; leaves coriaceous, glaucous, glabrous, or the basal scabridulous or scabrid-ciliolate, the basal lanceolate, tapering to the petiole, the cauline lance-oblong, broadest at the clasping base, 3-8 cm long, 5-15 mm wide; thyrsus racemiform, glabrous; calyx 3-5 mm high, the lobes ovate to orbicular, abruptly acute, the margin broadly scarious, entire to erose; corolla 18-24 mm long, carmine or "cherry red," not at all bluish or scarlet, blackening on drying, nearly tubular, the lobes rotately spreading or reflexed, glandular-pubescent without and densely glandular about orifice; anthers peltately explanate, glabrous; staminode uncinatate at apex, glabrous (very rarely with obsolete papillose beard at apex).

Occasional in canyons and mesas from southern Utah and northern Arizona to southern Nevada and eastern California, at elevations of 1200 to 2100 m. Type locality: "between Hatch's Wash and Monticello [Utah], May 28, 1892 [Eastwood]."

UTAH. Emery Co.: San Rafael Swell, May 13, 1914, *Jones* (C,F,GH,NY, Po,SU). San Juan Co.: between Hatch's Wash and Monticello, May 28, 1892, *Eastwood* (CAS, type; isotypes C,GH,M,Ph,Po,US). Garfield Co.: W. of Mt. Ellen, Kings Ranch, *Cottam* 5574 (Ph); Bryce Canyon, *Cottam* 4354 (Ph); Tropic, *Jones* 5312ae (US). Washington Co.: Zion National Park, Apr. 24, 1930, *Fisk* (M); Zion Canyon, *Cottam* 4780 (Ph), May 7, 1923, *Jones* (Po); Beaver Dam Mts., *Parry* 152 (F,GH,M,NY,Ph).

ARIZONA. Navajo Co.: Kayenta, 1922, *Wetherill* (NY). Coconino Co.: Bright Angel Trail, Grand Canyon, May 6, 1917, *Meiere* (GH); Hermit Creek, Grand Canyon, *Eastwood* 6027 (C,CI,F). Mohave Co.: Mokiak Pass, 20 mi. S. of St. George, *Palmer* 374 (GH,M,NY,US); Pagumpa, *Jones* 5082ac (US); 6 mi. N. of Wolfe Hole, *Benson* 54 (C); Clay Springs, Mar. 5, 1935, *Braem* (SU); Chloride, Apr. 14, 1903, *Jones* (Po,SU); Horse Spring, *Jones* 5070 (Po).

NEVADA. Clark Co.: Bunkerville, *Goodding* 743 (M,RM); Mica Mine, *Jones* 5070 (C,F,M,NY,Po,RM,US); Lower Clark Canyon, Charleston Mts., Mar. 28, 1934, *Jaeger* (Po), *Clokey & Anderson* 7306 (CI); Charleston Mts., *McKelvey* 4126 (CI); Good Springs, May 1915, *K. Brandegee* (C).

CALIFORNIA. San Bernardino Co.: New York Mts., near Ivanpah, *Ferris & Bacigalupi* 8086 (C,CI,SU); Vanderbilt, Mar. 20, 1932, *Jaeger* (CI); Barnwell, *Ferris & Bacigalupi* 8103 (C,CAS,CI,Po,SU); 5 mi. S. of Barnwell, *Munz* 13713 (CI,Ph, Po,SU); Ivanpah Mts., *Parish* 10317 (SU).

17. *Penstemon confusus* Jones

(Fig. 3)

Penstemon confusus Jones, *Zoe* 4:280, 1893.

Very similar to *P. utahensis* Eastw., the stems often lower and more leafy; corolla 14-20 or 22 mm long, reddish purple to rose-lavender or pink-violet, blackening on drying, slightly ampliate; anther-sacs not explanate, or, if explanate, longer than broad; staminode uncinatate, papillate-bearded, glabrate or naked.

KEY TO SUBSPECIES

- Corolla \pm glandular-pubescent without and about orifice; thyrsus virgate; anthers glabrous, or puberulent at suture, rarely ciliolate, sometimes explanate; staminode glabrous to obsoletely papillate-bearded. ----- 17a. *P. c.* subsp. *typicus*
 Corolla glabrous without and within; thyrsus more open and often decomposed; anthers scabrid-ciliolate, not explanate; staminode more densely papillose. ----- 17. *P. c.* subsp. *patens*

17a. *Penstemon confusus* subsp. *typicus* nom. nov.*Penstemon confusus* Jones, l. c.

Found to the north of *P. utahensis*, from central Utah to eastern Nevada. Type locality: "collected by me at Detroit, western Utah, May 26, 1891."

UTAH. Utah Co.: Homansville, May 16, 1891, Jones (Po). Juab Co.: Juab, June 9, 1902, Gooding (RM). Millard Co.: Detroit, May 26, 1891, Jones (Po, type; isotypes GH, M), probable isotypes, June 1891 (C, F, US). Sevier Co.: Salina Canyon, Jones 5419d (Po, US); Monroe, May 24, 1899, Jones (Po); top of grade between Marysvale and Monroe, Jones 5410h (US). Piute Co.: Marysvale, Jones 5338aa (US). 5388p (US). Beaver Co.: W. of Wa Wa, May 15, 1906, Jones (Po); Frisco, Jones 1819 (Cl, Po); 3 mi. E. of Beaver, Redeker 26 (RM). Iron Co.: Cedar City, Jones 5205w (Po, US), Tidestrom 9422 (US); Cedar Canyon, Collam et al. 3929 (Ph). "Kane Co.," Siler (Ph). Washington Co.: Pintura, Collam 4669 (Ph); Pine Valley, Stanton & Harrison 4067 (Ph); Silver Reef, Jones 5176u (Po, US); Bellevue, Collam et al. 3995 (Ph); Shem, Collam 5061 (Ph).

NEVADA. White Pine Co.: Ward Mtn., S. of Ely, Keck 623 (Cl, Ph, SU). Nye Co.: Currant, Bentley 7 (Cl, M, NY, Po, RM, SU, US). Lincoln Co.: Pioche, Minthorn 51 (C); Caliente, Tidestrom 9507 (Ph); Meadow Valley Wash, mile 16, Apr. 28, 1904, Jones (Po).

Perhaps all the collections from Washington County, Utah, combine features of this unit and *P. utahensis* Eastwood.

17b. *Penstemon confusus* subsp. *patens* (Jones) comb. nov.*Penstemon confusus* var. *patens* Jones, *Contr. West. Bot.* 12:63, 1908.

Sagebrush-covered hills surrounding Owens Valley, Mono and Inyo counties, California, at 1900 to 2200 meters elevation. Type: "Lone Pine, California, 7000 feet altitude, May 14, 1897 [Jones]."

CALIFORNIA. Mono Co.: Rock Creek, 23 mi. N. of Bishop, Keck 509 (C, CAS, Cl, F, GH, M, NY, Ph, Po, RM, SU, US); Sherwin Grade, Feudge 1412 (Po). Inyo Co.: Bishop, May 13, 1927, Jones (Po); Bishop Creek, Hall & Chandler 7256 (C); Lake Sabrina road, Benson 6003 (Lyman Benson Herb.); Andrews Camp, July 1913, K. Brandegee (C); Black Canyon, White Mts., Coville & Funston 1793 (GH, NY, SU, US); summit of Westgard Pass, Keck 546 (C, CAS, Cl, GH, Kew, M, NY, Ph, Po, SU, US); Lone Pine, May 14, 1897, Jones (Po, type; isotype US), May 13, 1927, Jones (CAS, Cl, Ph, Po, SU); mouth of Lone Pine Creek Canyon, Ferris 7443 (SU); Lone Pine Creek, Hall & Chandler 7211 (C, M, Po, SU).

This unit does not seem worthy of specific rank in spite of its apparent geographic isolation, because its several key distinctions reappear in some degree in collections of subsp. *typicus* from eastern Nevada.

18. *Penstemon Parryi* (Gray) Gray

Penstemon puniceus Gray var. ? *Parryi* Gray, in Torr., Bot. Mex. Bound. 113, 1859.

P. Parryi Gray, Syn. Fl. 2(1):264, 1878.

P. Shantzii A. Nels., Amer. Jour. Bot. 23:270, 1936. The type is Nelson 11263 (RM), from Boyce-Thompson Arboretum, near Superior, Arizona. I have not verified this but the description leaves no doubt as to its identity.

Glabrous and glaucous; stems few to several, 3-12 dm tall, virgate; basal leaves oblanceolate to spatulate or elliptic, the cauline narrowly lanceolate to lance-oblong, auriculate-clasping, obtuse at very tip, up to 12 cm long and to 2.5 cm wide; thyrsus virgate, half as tall as the stem, composed of up to 16 verticillasters; peduncles (erect or) divergent but short, few- to many-flowered; calyx 3-5 mm high, the lobes ovate, glabrous (rarely sparingly glandular-pubescent); corolla variable in size from 13-21 mm long, 5-7.5 mm broad, cerise or old rose or rose-magenta, with faint guide lines, the tube (of variable length) rather abruptly expanding into the ventricose throat, the limb spreading, glandular-puberulent without and anteriorly within, pilose at base of lower lip; anther-sacs peltately explanate and glabrous; staminode abruptly dilated apically and densely bearded with stiff retrorse yellow hairs, included.

Occasional in the higher and eastern portion of the Sonoran Desert, from Pinal County, Arizona, to southern Sonora, at elevations of 500 to 1500 meters. Type locality: "On the Rio Gila, March, 1852; *Parry*."

ARIZONA. ? Co.: Gila River, March 1852, *Parry* (GH, type); Hammock (possibly Mammoth intended??), Jones 29176 (C). Pinal Co.: Sandtank Pass, near Vekol Valley, 33 mi. S.E. of Gila Bend, *Keck* 3916 (C,CI,SU); Florence, *Norval* 1824 (CI); San Carlos, April 1932, *Ethel Palmer* (CAS); Table Top, *Harrison & Peebles* 9116 (C); 7 mi. E. of Mammoth, *Maguire et al.* 10880 (CI,Ph, Utah); Oracle, May 12, 1905, *Thornber* (UARiz); Peppersauce Wash, N. slope of Catalina Mts., *Graham* 3318 (SU). Pima Co.: Redington; Soldier Canyon trail below Vail's Corral, Santa Catalina Mts., *Graham* 3487 (SU); Pima Canyon, do., *Keck* 3952 (CI); Javalina Canyon, do., Apr. 11, 1937, *Glock* (CI); Sabino Canyon, do.; Tumamoc Hill, Tucson, *Wiggins* 6513 (CI,SU), *Keck* 2992 (C,CI,SU), 3935 (CAS, Ph,Po); Tucson Mts., 5 mi. W. of Tucson, *Keck* 3012 (CAS,CI,Ph); Tucson Recreational Area, *Goodding* 7 (CI,SU); Ft. Lowell, May 25, 1903, *Thornber* (UARiz); Colossal Cave, Rincon Mts., *McKelvey* 2560 (CI,Ph); between Continental and Range Reserve Station, Santa Rita Mts., *Graham* 3069 (SU); Baboquivari Mts., *Gilman* 1129 (CI,Ph), *Goodding* 4 (CI,SU); 75 mi. W. of Tucson on road to Ajo, *Wiggins* 6518 (CI,SU). Santa Cruz Co.: Nogales, May 1892, *T. S. Brandegee* (C). Cochise Co.: Bisbee, *Gooding* 79 (UARiz); Warren, May 20, 1915, *Carlson* (CAS); Swisshelm Mts., *Goodding* 2245 (C,M).

SONORA. 30 mi. S. of Nogales on road to Imuris, *Abrams* 13146 (CI,SU); Magdalena, *Kennedy* 7066 (CAS,CI); San Jose del Campo, El Alamo, near Magdalena, May 22, 1925, *Kennedy* (C); 10 mi. S. of Llano, *Abrams* 13269 (SU); Rio Seco, 27.7 mi. S. of Sasabe on road to Altar, *Keck* 3986 (C,CI,Ph,SU); 14 mi. N. of Quitovac on road to Sonoyta, *Keck* 4146 (C,CI,SU); San Bernardo, Rio Mayo, *Gentry* 1319 (Desert Lab., Carnegie Institution, Tucson).

A collection from Peach Springs, Arizona, July 1884, *Lemmon* (C), is doubtless an introduction or the locality is erroneously given, for the species has not been recollected in modern times in Mohave County. Likewise, a collection of this species from Mente Alban, Oaxaca, *Donnelly* 11 (C), is possibly a garden plant.

Rarely a plant is found in which a few of the cauline leaves are obscurely serrulate. This may be taken as further evidence in support of the view that subsection *Centranthifolii*, of which this species is a member, approaches very closely to subsection *Spectabiles* at this point.

An important series of *Penstemons* has just come to hand from Dr. Carl B. Wolf, botanist of the Rancho Santa Ana Botanic Garden, and records made by him in the Kingston Range, particularly in the vicinity of Crystal Spring, in an hitherto botanically unexplored portion of the eastern Mohave Desert, in the extreme northeastern corner of San Bernardino County, California, should be added to the foregoing account. In that vicinity he has found:

Penstemon utahensis Eastwood, *Wolf* 6826, 6829 (SAna).

Penstemon fruticiformis Cov., *Wolf* 6805 (SAna). This collection combines features of subsp. *typicus* and *amargosae*, thereby tending to minimize the importance of the distinctions between the two. The sepals are rotund-ovate but more narrowly acute than is usual in *typicus*, the buds are glandular-pubescent without like *amargosae*, but the throat within is moderately glandular-pubescent posteriorly to an intermediate degree.

Penstemon Palmeri Gray subsp. *typicus* Keck, *Wolf* 6830 (SAna). This species has been collected in San Bernardino County also on the south side of Clark Mountain, below the Copper World Mine, *Wolf, Johnson & Everett* 8280 (SAna); and at Moore's Ranch, 15 mi. S. of Cima, *Stark* 2255 (SAna).

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The Orchidaceae of the Rocky Mountains

Louis O. Williams

The following account of the Orchidaceae of the Rocky Mountains is an attempt to put into convenient form and to bring up to date our knowledge of the orchids of this most interesting but not too well known region.

The region covered by his treatment extends southward from the mountainous part of southern British Columbia and Alberta and includes all of the states of Montana, Wyoming, Colorado, Idaho and Utah, as well as the mountainous portion of northern New Mexico.

The range of each species and variety is given, first for the region indicated as completely as it is known to the author, and second a general statement of the range of the entity involved outside of the area covered by this paper.

In giving synonymy of the various entities the name-bringing synonym is given, if there is one, and only such other synonyms as are concerned with the region in question, either from having been in common usage or from having been applied to a plant from that region.¹

For the region as outlined there are but ten genera of orchids, comprising some twenty-nine species and three varieties, one of these dubiously within that range. Contrasted with many much smaller regions the Rocky Mountain area is comparatively poor in orchids, both in number of species and in beautiful species. However that may be, the Rocky Mountain orchids are none the less interesting. The author envies the student of the Rocky Mountain flora his thrill when he finds his first *Calypso* or *Cypripedium*.

The treatment here presented is conservative both as to specific and generic limitation. The author believes that this attitude will be welcomed by the students of our flora. *Habenaria* and *Corallorrhiza* are notoriously difficult, and an attempt to differentiate all of the species which have been proposed, to say nothing of the proposed generic segregates of *Habenaria*, leads to no end of uncertainty. Even the few species which must be maintained are sometimes rather difficult to identify correctly. The treatment of *Habenaria* here used follows very closely that presented by Oakes Ames in his monograph "The Genus *Habenaria* in North America."

This study is based, primarily, on three collections—the Rocky Mountain Herbarium, the Orchid Herbarium of Professor Oakes Ames and the Gray Herbarium. To the gentlemen in charge of these herbaria, Professor Aven Nelson, Professor Oakes Ames and Professor M. L. Fernald, the author is much indebted for the privilege of studying this material. To the former two

¹ For full synonymy, up to 1924, see Ames, Enumeration of the Orchids of the United States and Canada. (The American Orchid Society. Boston. 1924.)

and to Mr. Charles Schweinfurth he is further indebted for assistance during the rather extended course of this study.

ORCHIDACEAE Lindl. Orchid Family.

Herbs, distinguished by perfect zygomorphic gynandrous flowers with a 6-merous (sometimes apparently 5-merous) perianth adnate to the 1-celled ovary, the ovary with numerous ovules on three parietal placentae and with either one or two fertile stamens, the pollen cohering in masses. Perianth segments in two sets or series, the outer (sepals) similar or nearly so; the lateral ones of the three inner segments (petals) similar, the other, termed the lip, differs from the rest in shape and size and is sometimes prolonged at the base into a spur. At the base of the lip in the axis of the flower is the column, composed of a single fertile stamen, or in *Cypripedium* two fertile stamens and the rudiment of a third, variously coalescent with the style and the stigma. Anthers 2-celled, each containing one, or more, pollen masses which are termed pollinia, or in *Cypripedium* they are granular. Stigma viscid or rough. Ovary inferior, 1-celled, 3-valved. Flowers solitary or in racemes or spikes. Leaves solitary or several and alternate or apparently opposite, parallel-veined.

KEY TO THE GENERA

Fertile anthers two; lip an inflated sac, never produced in front -----1. *Cypripedium*.

Fertile anther one; lip not an inflated sac, or if inflated produced into a lamina.

Flower solitary, terminal -----2. *Calypso*.

Flowers not solitary, racemose or spicate.

No green leaves present; saprophytes -----10. *Corallorrhiza*.

Green leaves present; not saprophytes.

Flowers with a distinct slender spur.

Lip purple-spotted, toothed at the base; caudicles of the pollinia convergent -----3. *Orchis*.

Lip neither purple-spotted nor toothed at the base; caudicles of pollinia divergent -----4. *Habenaria*.

Flowers without a distinct spur, the lip sometimes saccate at the base.

Leaves cauline.

Leaves 2, near the middle of the plant, apparently opposite -----6. *Listera*.

Leaves more than 2, alternate.

Flowers 1-2 cm. long, lax, not spiraled -----9. *Epipactis*.

Flowers less than 1 cm. long, densely spiraled 5. *Spiranthes*.

Leaves basal, or because of the elongated, sheathing petiole appearing to be born on the stem.

Leaves 1 or sometimes 2, not blotched; cauline bracts none -----7. *Malaxis*.

Leaves more than 2, sometimes blotched; cauline bracts present -----8. *Goodyera*.

1. CYPRIPIEDIUM L. Lady's Slipper

Glandular pubescent, caulescent herbs with coarse fibrous roots; flat several-nerved leaves with sheathing bases and flowers one to several in a terminal

raceme. Sepals spreading, the two lateral ones often united under the inflated sac-like lip. Fertile anthers two, one on each side of the short incurved column and a sterile one covering the summit of the column. Pollen granular. Stigma obscurely 3-lobed.

Leaves 2, nearly opposite; flowers dark purple ----- 1. *C. fasciculatum*.
Leaves several, definitely alternate; flowers not purple.

Lip white, purple veined; sterile stamen ovate or obovate ----- 2. *C. montanum*.

Lip yellow; sterile stamen triangular, yellow and purple spotted.

Lip 2-2.5 cm. long; upper sepal largest, longer than the lip 3. *C. parviflorum*.

Lip 3-4 cm. long; upper and lower sepals subequal, shorter than the

lip ----- 3a. *C. parviflorum* var. *pubescens*.

1. *C. fasciculatum* Kellogg ex S. Wats. in Proc. Am. Acad. 17: 380. 1882.

C. Knightae A. Nels. in Bot. Gaz. 42:48. 1906.

Plant 6-15 cm. tall, bearing a pair of nearly opposite leaves. Leaves broadly ovate, rounded or obtuse, thick; floral bracts large, elliptic-lanceolate; flowers small, 2-3 in a cluster, dark purple; lower sepals united almost to the tips, ovate-lanceolate; petals similar, shorter than the sepals; lip 10-12 mm. long, shorter than the sepals and petals.—Scattered in the mountains of western Montana south to central Colorado and the Uinta Mountains, Utah. Also in the Pacific Coast States.

2. *C. montanum* Dougl. ex Lindl., Gen. & Sp. Orch. 528. 1840.

Plant 3-5 dm. tall. Leaves several, alternate, oval to lanceolate, 5-13 cm. long, glandular pubescent on the veins; inflorescence 1-3-flowered; sepals linear-lanceolate, 4-5 cm. long, greenish-brown; petals linear, 4-5 cm. long; lip white, purple-veined, 2.5-3 cm. long.—Open woods along the mountains. British Columbia to Wyoming and Idaho. Also in the Pacific States.

3. *C. parviflorum* Salisb. in Trans. Linn. Soc. 1: 77. 1791.

Plant 1.5-4 dm. tall, commonly one-flowered. Leaves oval to broadly lanceolate, acute or acuminate; upper sepal acuminate-lanceolate, about 3 cm. long and 1 cm. broad, the lateral ones narrower; petals linear, exceeding the sepals; lip yellow, 2-2.5 cm. long, broader than deep.—Woods. From British Columbia to Wyoming (& Colorado?). Eastward.

3a. *C. parviflorum* var. *pubescens* (Willd.) Knight in Rhodora 8: 93. 1906.

C. pubescens Willd., Hort. Berol. 1: pl. 13. 1804.

C. veganum Ckll., Barker & Barker in Proc. Biol. Soc. Wash. 14:178. 1901.

Plant 2-4 dm. tall, one-flowered. Leaves elliptic-lanceolate, acute or acuminate, glandular-pubescent, 8-15 cm. long; sepals about 3 cm. long and 1 cm. broad, usually shorter than the lip; petals 4.5-5.5 cm. long, linear-lanceolate; lip yellow, 3-4 cm. long, as deep or deeper than broad.—(British Columbia?), Colorado and northern New Mexico, in our range. Eastward.

2. CALYPSO Salisb. Calypso

Low herb with a solid corm and coralloid roots, the one-flowered scape with 2-3 loose sheaths at the base and bearing a single petiolate leaf from the base. Flowers large, terminal, showy (rarely with more than one flower).

Sepals and petals similar, narrowly lanceolate. Lip large, saccate and with a flange. Column concave, petaloid, bearing the lid-like anther just below the apex, stigmatic toward the base. Pollinia 2, waxy, each 2-parted, the lower smaller, sessile on the thick gland. (*Cytherea* Salisb.).

1. *C. bulbosa* (L.) Oakes in Thompson, Hist. Vermont, part 1, p. 200. 1842.

Cypripedium bulbosum L., Sp. Pl. ed. 1. 2: 951. 1753.

Calypso borealis Salisb. Par. Lond. pl. 89. 1807.

Calypso bulbosa f. *occidentalis* Holz. in Contr. U. S. Nat. Herb. 3: 251. 1895.

Calypso occidentalis Heller in Bull. Torr. Bot. Club 25:193. 1898.

Cytherea bulbosa House in Bull. Torr. Bot. Club 32:382. 1905.

As the genus.—Rich moist woods throughout our range. Also to northern California and across the continent eastward. Europe and Asia.

3. ORCHIS [Tourn.] L. Orchis

Roots tuberous and of numerous fleshy fibers; stems scape-like, with one leaf at the base. Inflorescence a short terminal spike. Sepals and petals separate, subequal, spreading. Lip connate with the column, produced below into a spur, 3-lobed (at least in our species). Anther 2-celled, the cells contiguous and parallel. Pollinia granulate, their caudicles laterally attached to the naked gland in a pouch or bursicle.

1. *Orchis rotundifolia* (Richards.) Banks ex Pursh, Fl. Am. Sept. 2: 588. 1814.

Habenaria rotundifolia Richards. in Frankl. Narr. 1st Jour. 750. 1823.

Platanthera rotundifolia Lindl., Gen. & Sp. Orch. 292. 1835.

Stem slender, 1-2 dm. tall, one leaf near the base subtended by one or two sheathing scales. Leaf from nearly orbicular to oval, 3-6 cm. long; flowers about 15 mm. long, 1-6 in the spike; sepals elliptic, 6-7 mm. long, the lateral ones spreading; petals similar but shorter; lip white, spotted with purple, three-lobed, with the much enlarged middle lobe retuse at the apex; spur curved, slender, shorter than the lip.—Moist woods. British Columbia to Wyoming. Also northeastward.

4. HABENARIA Willd. Rein Orchis. Habenaria

Glabrous plants with one or more leaves; tuberoids elongated, fusiform or palmate. Flowers usually small, in racemes. Sepals spreading, usually similar. Petals erect, connivent with the upper sepal. Lip simple, 3-lobed or toothed at the apex. Spur various, shorter or longer than the lip, often dilated at the base. Glands or disk, to which the pollen masses are attached, naked or exposed, separate, often widely so.—A polymorphic genus from which several genera have been segregated. (*Limnorchis* Rydb.; *Lysiella* Rydb.; *Piperia* Rydb.; *Montolivaea* Rydb.; *Platanthera* in part; *Coeloglossum* in part).

Bracts leaf-like, several times longer than the flowers; lip bi- or trilobed at apex.

-----1. *H. bracteata*.

Bracts not leaf-like, not several times longer than the flower; lip entire.

- Leaves basal, rarely more than 2.
 Leaves nearly as broad as long or suborbicular.....9. *H. orbiculata*.
 Leaves twice as long as broad or longer.
 Plant with a single obovate or oblanceolate basal leaf at flowering time8. *H. obtusata*.
 Plant without green leaves at flowering time.
 Spur as long as the lip6. *H. unalascensis*.
 Spur twice as long as the lip7. *H. elegans*.
 Leaves cauline, usually more than 2.
 Lip rhombic-lanceolate, dilated at the base.
 Spur about equaling the lip2. *H. dilatata*.
 Spur exceeding the lip2a. *H. dilatata* var. *leucostachys*.
 Lip lanceolate or linear, not conspicuously dilated at the base.
 Lip lanceolate; spur not conspicuously or but slightly longer than the lip.
 Flower green; spur not dilated at the base3. *H. hyperborea*.
 Flower purple; spur dilated at the base
3a. *H. hyperborea* var. *purpurascens*.
 Lip linear or nearly so; spur shorter or nearly equaling the lip.
 Spur shorter than the lip, saccate4. *H. saccata*.
 Spur nearly equaling the lip, not saccate5. *H. sparsiflora*.

1. *H. bracteata* (Willd.) R. Br. in Ait. Hort. Kew. ed. 2. 5: 192. 1813.

Orchis bracteata Muhl. ex Willd., Sp. Pl. 4:34. 1805.

Platanthera bracteata Torr., Fl. N. Y. 2:279. 1843.

Habenaria viridis (L.) R. Br. var. *bracteata* Gray, Man. Bot. N. U. S. ed 5. 500. 1867.

Stem leafy even through the inflorescence, leaves reduced upward, the lower oblanceolate to obovate, the upper oblong to lanceolate, acute, floral leaves or bracts 2-5 times as long as the flower; sepals spreading, mostly similar; petals linear; lip oblong or slightly spatulate, 2-3-toothed at the apex, the lateral teeth usually larger, lip more than twice as long as the saccate spur; tuberosities somewhat palmate.—Damp woods. British Columbia to Colorado. Eastward.—This plant is maintained as a variety of *H. viridis* by Oakes Ames in his monograph of "The Genus *Habenaria* in North America."

2. *H. dilatata* (Pursh) Hook., Exot. Fl. 2: pl. 95. 1895.

Orchis dilatata Pursh, Fl. Am. Sept. 2:588. 1814.

Habenaria borealis Cham. in Linnaea 3:28. 1828.

H. dilatatiformis Rydb. in Bull. Torr. Bot. Club 24:189. 1897.

H. gracilis Rydb. l.c., not S. Wats.

Limnorchis dilatatiformis Rydb. in Mem. N. Y. Bot. Gard. 1:105. 1900.

L. borealis Rydb. in Bull. Torr. Bot. Club 28: 621. 1901.

L. dilatata Rydb. ex Britt., Man. Fl. N. States and Canada 294. 1901.

L. gracilis Rydb. in Bull. Torr. Bot. Club 28: 627. 1901.

L. leptoceratitis Rydb. in Bull. N. Y. Bot. Gard. 2:162. 1901.

Stem leafy, 1-6 dm. tall. Leaves oblong-lanceolate, obtuse or acute, 4-10 cm. long, 1-3 cm. broad; flowers white; upper sepal ovate, lateral sepals narrower; petals lanceolate, erect; lip lanceolate with a dilated base; spur about equalling the lip, slender at the base; glands of the stigma orbicular.—Stream banks and wet woods throughout our range. Also northward and eastward.

2a. *H. dilatata* var. *leucostachys* (Lindl.) Ames, Orch. 4: 71. 1910.

Platanthera leucostachys Lindl., Gen. & Sp. Orch. 288. 1835.

Habenaria leucostachys S. Wats. in Bot. Cal. 2:134. 1880.

Limnorchis leucostachys Rydb. in Mem. N. Y. Bot. Gard. 1:106. 1900.

Similar to the species and a doubtful variety. Spur exceeding the lip.—Throughout our range. Northward and westward.

3. *H. hyperborea* (L.) R. Br., Prodr. 312. 1810.

Orchis hyperborea L., Mant. 121. 1767.

Limnorchis hyperborea Rydb. in Mem. N. Y. Bot. Gard. 1:104. 1900.

Similar to the preceding species. Flowers greenish; lip lanceolate, deflexed or curved upward, *not* dilated at the base.—Stream banks, moist woods and meadows. Throughout our range. Northward and eastward.

4. *H. saccata* Greene in Erythea 3: 49. 1895.

Platanthera gracilis Lindl., Gen. & Sp. Orch. 288. 1835.

P. stricta Lindl. l.c.

Habenaria gracilis S. Wats. in Proc. Am. Acad. 12:277. 1877, nec Colebr. nec Lindl. nec Reichb. f.

H. stricta Rydb. in Bull. Torr. Bot. Club 24: 189. 1897, nec Rich. & Gal. nec Ridl.

Limnorchis stricta Rydb. in Mem. N. Y. Bot. Gard. 1:105. 1900.

L. gracilis Rydb. in Bull. Torr. Bot. Club 28:627. 1901.

Stems leafy, 2-4 dm. tall. Leaves lanceolate, acute, 4-8 cm. long; upper sepal ovate-oblong, lateral sepals oblong-lanceolate; petals falcate; lip linear; spur saccate, shorter than the lip.—Stream banks and moist woods. Throughout our range. Northward and westward.

5. *H. sparsiflora* S. Wats. in Proc. Am. Acad. 12: 276. 1877.

Limnorchis ensifolia Rydb. in Bull. Torr. Bot. Club 28:629. 1901.

L. laxiflora Rydb. l.c. 630.

L. sparsiflora Rydb. l.c. 631.

Stems more or less leafy, 1.5-5 dm. tall; raceme lax. Leaves oblong to linear-lanceolate, acute, attenuate; upper sepal ovate, lateral sepals oblong or lanceolate, 4-6 mm. long; lip linear or narrowly lanceolate, 6-8 mm. long, equaling or exceeding the narrow spur; glands orbicular.—Stream banks and bogs. Colorado and New Mexico. Also in Utah and northwestward and westward.

6. *H. unalascensis* (Spreng.) S. Wats. in Proc. Am. Acad. 12: 277. 1877.

Spiranthes unalascensis Spreng., Syst. Veg. 3:708. 1826.

Montolivaea unalascensis Rydb. in Mem. N. Y. Bot. Gard. 1:107. 1900.

Piperia unalascensis Rydb. in Bull. Torr. Bot. Club 28:270. 1901.

Stems slender, erect, 3-5 dm. tall, with leaves at or near the base only. Leaves oblanceolate, obtuse or acute, usually withering before anthesis; bracts lanceolate or broader, shorter than the spirally arranged flowers; sepals and petals lanceolate; lip oblong, obtuse; spur linear, barely equaling or shorter than the lip.—Woods. Throughout our range. Northward and westward.

7. *H. elegans* (Lindl.) Bolander, Fl. San Franc. 29. 1870.

Platanthera elegans Lindl., Gen. & Sp. Orch. 285. 1835.

Montolivaea elegans Rydb. in Mem. N. Y. Bot. Gard. 1:106. 1900, non Reichb. f.

Piperia elegans Rydb. in Bull. Torr. Bot. Club 28:270. 1901.

P. lancifolia Rydb. l.c. 637.

P. multiflora Rydb. l.c. 638.

Habenaria multiflora Blankinship in Mont. Agr. College Sci. Stud. 1:45. 1905.

Similar to the preceding species; distinguished by the spur which is more than twice as long as the lip.—Moist woods. British Columbia to Montana and Idaho. Also in the Pacific Coast States.

8. *H. obtusata* (Pursh) Richards. in Frankl., Journ. App. 750. 1823.

Orchis obtusata Pursh, Fl. Am. Sept. 2:588. 1814.

Platanthera obtusata Lindl., Gen & Sp. Orch. 284. 1835.

Lysiella obtusata Rydb. in Mem. N. Y. Bot. Gard. 1:104. 1900.

Stems scapiform with a single obovate or oblanceolate leaf at the base, 1-2 dm. tall. Leaf 4-10 cm. long; upper sepal broad and rounded, lateral sepals and petals lance-oblong; lip entire, linear-lanceolate, deflexed, about 6 mm. long, about equal to the tapering, curved spur.—Woods. British Columbia to Colorado. Eastward and northward.

9. *H. orbiculata* (Pursh) Torr., Comp. 318. 1826.

Orchis orbiculata Pursh, Fl. Am. Sept. 2:588. 1814.

Platanthera orbiculata Lindl., Gen. & Sp. Orch. 286. 1835.

Lysias orbiculata Rydb. in Mem. N. Y. Bot. Gard. 1:103. 1900.

Plant acaulescent, 1-5 dm. tall. Leaves 2, basal, orbicular or broadly elliptic, 5-12 cm. broad, spreading flat on the ground; raceme loose, 10-20-flowered, flowers greenish-white; upper sepal orbicular, lateral sepals ovate; lip oblong-linear, obtuse, 1.5-2 cm. long; spur equaling the lip.—Woods. British Columbia, Montana and Idaho. Also westward, northward and eastward.

5. SPIRANTHES Rich. Lady's Tresses

Erect strict herbs from a cluster of tuberous roots. Flowers small, spurless, in spirally arranged spikes of 1-3 rows. Sepals and petals narrow, more or less connivent. Lip oblong or pandurate, sessile or nearly so, the base embracing the short, erect column. (*Gyrostachys* Pers.; *Ibidium* Salisb.).

1. *Spiranthes Romanzoffiana* Cham. & Schl. in Linnaea 3: 32. 1828.

Gyrostachys Romanzowiana MacM. in Met. Minn. 171. 1892.

Orchiastrum Romanzoffianum Greene, Man. Bot. Reg. S. F. Bay 306. 1894.

Gyrostachys stricta Rydb. ex. Britt., Man. Bot. N. States & Canada 299. 1900.

Ibidium strictum House in Bull. Torr. Bot. Club 32:381. 1905.

Ibidium Romanzoffianum House in Muhlenbergia 1:129. 1906.

Spiranthes stricta A. Nels. in Coult. & Nels. Man. Bot. Ry. Mts. 125. 1909.

Spiranthes Romanzoffiana var. *stricta* Daniels in Univ. Mo. Stud. 2:96. 1911.

Herb 1-10 dm. tall, occasionally sparingly glandular pubescent. Leaves from oblong-ob lanceolate to linear-lanceolate; spike dense, flowers 3-ranked, conspicuously bracted; lip recurved, pandurate, callosities often obscure.—Moist situations. Throughout our range. Eastward, northward and westward.

6. *LISTERA* R. Br. Tway-blade

Perennial herb with root-stalks and fibrous roots. Leaves 2, sessile, opposite, near the middle of the stem. Flowers small in a terminal raceme, greenish or purplish. Sepals and petals similar. Lip notched or cleft at the apex and often with a pair of teeth toward the base, longer than the sepals.

- Lip narrow, cleft half way to the base1. *L. cordata*.
 Lip broad, merely notched at the apex.
 Lip auriculate at the base2. *L. borealis*.
 Lip not auriculate, expanded above.
 Lip clawed; ovary glandular3. *L. convallarioides*.
 Lip sessile; ovary glabrous4. *L. caurina*.

1. *L. cordata* (L.) R. Br. in Ait. Hort. Kew. ed. 2. 5: 201. 1813.

Ophrys cordata L., Sp. Pl. ed. 1. 2:946. 1753.

Listera nephrophylla Rydb. in Mem. N. Y. Bot. Gard. 1:108. 1900.

Ophrys nephrophylla Rydb. in Bull. Torr. Bot. Club 32:610. 1905.

Stem slender, 1-2 dm. tall, glabrous. Leaves cordate to rounded-reniform, mucronate; flowers greenish or purplish; sepals and petals oblong, similar, much shorter than the lip; lip 4-5 mm. long, cleft to the middle or more, the segments linear, a short tooth on each side at the base; capsule ovoid.—Moist woods. Throughout our range. Eastward, northward and westward. Europe. Asia.

2. *L. borealis* Morong in Bull. Torr. Bot. Club 20: 31. 1893.

Ophrys borealis Rydb. in Bull. Torr. Bot. Club 32:610. 1905.

Stems slender, 7-15 cm. tall, glabrous below the leaves, pubescent above them. Leaves 1.5-3.5 cm. long and 1-2.5 cm. broad, elliptic-ovate, obtuse, borne above the middle of the stem; sepals and petals similar; lip oblong, 5-6 mm. long, wider at both ends than in the middle, with two obtuse lobes at the apex, 2 obtuse auricles at the base.—Moist woods and swamps. British Columbia to Colorado and Utah. Northward and eastward.

3. *L. convallarioides* (Sw.) Nutt., Gen. N. Am. Pl. 2: 191. 1818.

Epipactis convallarioides Sw. in Kongl. Sv. Vet. Acad. Nya Handl. II. 21:232. 1800.

Ophrys convallarioides W. F. Wight ex House in Bull. Torr. Bot. Club 32:380. 1905.

Stem slender, 1-3 dm. tall, pubescent above the leaves. Leaves orbicular to broadly ovate, often abruptly acute, or obtuse at the apex, 3-5 cm. long; sepals and petals similar; lip about 9 mm. long, narrowly cuneate, 2-lobed at the apex, often with a blunt spreading tooth on each side near the base.—Moist woods. British Columbia to Wyoming and Idaho. Westward, northward and eastward.

4. *L. caurina* Piper in *Erythea* 6: 32. 1898.

Ophrys caurina Rydb. in *Bull. Torr. Bot. Club* 32:610. 1905.

Stem slender, 1-2 dm. tall, glandular-pubescent above the leaves. Leaves obovate to oval or elliptical-ovate, obtuse, 3-6 cm. long; flowers dull yellow or greenish; sepals and petals lanceolate to lanceolate-linear, 3-4 mm. long; lip narrowly oblong, dilated and rounded at the retuse apex, with a slender filiform tooth on each side at the base; capsule ovoid.—Moist woods. Montana and Idaho. Westward and northward.

7. MALAXIS Swartz.² Adder's Mouth

Low caulescent herbs from solid bulbs and with one or two leaves spreading from the stem at some distance from the base. Flowers small, in a terminal raceme or spike. Sepals spreading, separate. Petals filiform or linear, spreading. Lip cordate or auriculate at the base. (*Microstylis* Nutt.; *Achroanthes* Raf.).

Flowers greenish, in a dense spike 1. *M. macrostachya*.
Flowers purplish, in a loose raceme 2. *M. Ehrenbergii*.

1. *Malaxis macrostachya* (Lindl.) O. Kuntze, *Rev. Gen. Pl.* 2: 673. 1891.

Microstylis montana Rothrock in *Wheeler Rep. U. S. Geol. Surv.* 100th Merid. 6:264. 1878.

Malaxis montana O. Kuntze, *Rev. Gen. Pl.* 2:637. 1891. non Blume.

Achroanthes montana Greene, *Pittonia* 2:183. 1891.

Malaxis Soulei L. Wms. in *Ann. Mo. Bot. Gard.* 29:343. 1934.

Plant slender, commonly 1-2 dm. tall, with 1-3 sheaths at the base. Leaves one or two, elliptic to oblong-lanceolate, the bases sheathing the stem; flowers many, small, sessile crowded in a long narrow spike, yellowish-white or greenish, subtended by an oval bract 1-2 mm. long; petals filiform, often coiled; lip appressed to the axis, triangular-ovate, sagittate at the base and obtuse or retuse at the apex; column short; anthers nearly sessile, of two parallel cells.—Rare in the mountains of New Mexico. South and southward.

2. *Malaxis Ehrenbergii* (Reichb. f.) O. Kuntze, *Rev. Gen. Pl.* 2: 673. 1891.

Microstylis Ehrenbergii Reichb. f. in *Linnaea* 22:835. 1849.

Microstylis purpurea S. Wats. in *Proc. Am. Acad.* 18:195. 1883.

Microstylis porphyrea Ridley in *Journ. Linn. Soc.* 22:320. 1886.

Malaxis porphyrea O. Kuntze, l.c.

Malaxis purpurea O. Kuntze, l.c.

Achroanthes purpurea Greene, *Pittonia* 2:184. 1891.

Achroanthes porphyrea Woot. & Standl. in *Contr. U. S. Nat. Herb.* 16:116. 1913.

Stems 1.5-4 dm. tall, with a clasping obtuse sheath at the base. Leaf 1, cordate-ovate, clasping, 5-10 cm. long; raceme elongated, loosely flowered in anthesis; pedicels 2-4 mm. long, each subtended by a minute bract; flowers purple, small; lip triangular-lanceolate, slightly auriculate at the base; capsule

² It is possible that this genus does not occur in our range, although both species may reach the southern limit of the range.

about 4 mm. long, round ovate.—Rare in the mountains of New Mexico. South and southwestward.

8. GOODYERA R. Br. Rattlesnake Plantain

Herbs with a creeping rootstalk, thick roots and with the alternate leaves basal or nearly so. Inflorescence spicate, braceate, flowers white or pink, inconspicuous. Dorsal sepal and the petals connate into a hood over the lip. Lip saccate with a straight or recurved tip, sessile, entire. Column straight, short. Fertile anther one, dorsal. Pollinia 2, one in each cell of the anther. (*Epictatis* [Haller] Boehm., *Peramium* Salisb.).

Flowers in a one-sided raceme, lax; lip deeply saccate1. *G. repens*.
Flowers in a loose spiral; lip scarcely saccate2. *G. decipiens*.

1. *G. repens* (L.) R. Br. in Ait., Hort. Kew. ed. 2. 5: 198. 1813.

Satyrium repens L., Sp. Pl. ed. 1. 2:945. 1753.

Peramium repens Salisb. in Trans. Hort. Soc. ed. 1. 1:301. 1812.

Epipactis repens Crantz, Stirp. Austr. ed. 2. 2:473. 1769.

Orchiodes repens O. Kuntze, Rev. Gen. Pl. 2:674. 1891.

Scale 1-2 dm. tall, glandular pubescent, with 2-4 sheaths. Leaves 1-2 cm. long, broadly ovate, abruptly contracted into a short winged petiole (the variety *ophioides* Fernald, in *Rhodora* 1: 6. 1899, with the veins of the leaves conspicuously bordered with white may possibly occur in our range); flowers greenish-white; lip deeply saccate, margin and tip recurved; anthers blunt.—Moist mountain woods. British Columbia to Colorado. Eastward. Europe and Asia.

2. *G. decipiens* (Hook.) F. T. Hubbard in Standardized Plant Names 328. 1923.

Spiranthes decipiens Hook., Fl. Bor.-Am. 2:203, pl. 204. 1839.

Goodyera Menziesii Lindl., Gen. & Sp. Orch. 492. 1840.

Peramium Menziesii Morong in Mem. Torr. Bot. Club 5:124. 1894.

Peramium decipiens Piper in Contr. U. S. Nat. Herb. 11:208. 1906.

Epipactis decipiens Ames, Orch. 2:261. 1908.

Scale 1-3 dm. tall, rather stout, together with the inflorescence pubescent. Leaves ovate-lanceolate, 4-6 cm. long, acute at both ends, often reticulated with lighter markings and a white band in the middle; spike many-flowered; lip scarcely saccate.—Woods. British Columbia to Wyoming and Idaho. Eastward, northward and westward.

9. EPIPACTIS Zinn.

Tall simple-stemmed herbs from creeping root-stalks. Leaves several, ovate to lanceolate, plicate, sheathing. Flowers few in a leafy-bracted raceme. Sepals and petals similar, all separate. Lip constricted near the middle, sessile, broad, concave below. Spur none. Column short and erect. Anther one, sessile, behind the truncate stigma. (*Serapias* L., *Amesia* Nels. & Macbr.)

1. *Epipactis gigantea* Dougl. ex Hook., Fl. Bor.-Am. 2: 202. 1839.

Serapias gigantea A. A. Eaton in Proc. Biol. Soc. Wash. 21:67. 1908.

Amesia gigantea Nels. & Macbr. in Bot. Gaz. 56:472. 1913.

Plant 3-10 dm. tall. Leaves from ovate to lanceolate, somewhat scabrous on the veins below; flowers greenish, strongly veined with purple; lip saccate at the base.—Moist situations. Montana southward in our range. Westward and southward.

10. CORALLORRHIZA [Haller] R. Br. Coral Root

Leafless saprophytic herbs with coralloid roots, the scape, with 2-4 membranaceous sheaths, bearing a spike of purplish, brownish or yellow flowers. Sepals nearly equal, the lateral ones often forming a short saccate spur which may be partly or wholly adnate to the top or one side of the ovary; petals similar to the sepals but usually smaller; lips simple or 3-lobed.

Lip entire or only denticulate, not lobed.

Sepals and petals striate; lip purple, not maculate.

Sepals and petals 10-15 mm. long1. *C. striata*.

Sepals and petals 6-8 mm. long1a. *C. striata* var. *Vreelandii*.

Sepals and petals not striate; lip white, maculate3. *C. Wisteriana*.

Lip 3-lobed or 3-dentate.

Lip white.

Lip spotted with crimson or magenta, 7-8 mm. long2. *C. maculata*.

Lip not spotted, about 5 mm. long4. *C. trifida*.

Lip purple5. *C. Mertensiana*.

1. *C. striata* Lindl., Gen. & Sp. Orch. 534. 1840.

C. ochroleuca Rydb. in Bull. Torr. Bot. Club 31:402. 1904.

Plant stout, 1.5-5 dm. tall, the stem purple or in albino forms yellowish, 10-30-flowered. Sepals and petals linear-lanceolate, 10-15 mm. long and 2-3 mm. broad; lip ovate or elliptic, somewhat concave and fleshy, with 2 short approximate lamellae at the base; column about as long as the perianth parts; capsule cylindrical; spur wanting.—Woods. British Columbia to Colorado and Utah. Eastward and westward.

1a. *C. striata* var. *Vreelandii* (Rydb.) L. Wms. in Ann. Mo. Bot. Gard. 21: 343. 1934.

C. Vreelandii Rydb. in Bull. Torr. Bot. Club 28:271. 1901.

Similar to the species except that the perianth parts are only 6-8 mm. long.—Woods. Colorado, New Mexico and Utah.

2. *C. maculata* Raf. in Am. Mo. Mag. 2: 119. 1817.

C. multiflora Nutt. in Journ. Acad. Nat. Sci. Phila. 3:138, t. 7. 1823.

C. multiflora β *occidentalis* Lindl., Gen. & Sp. Orch. 534. 1840.

C. multiflora var. *flavida* Peck in 15th Rep. Bot. N. Y. 126. 1897.

C. Grabhamii Ckll. in Torreyia 3:140. 1903.

C. maculata var. *flavida* Ckll. in Torreyia 16:232. 1916.

C. maculata var. *occidentalis* Ckll., l.c.

Plant stout, 2-4 dm. tall, the stems purple or in albino forms yellowish, 10-30-flowered. Sepals and petals linear, about 8 mm. long and 1.5 mm. broad; lip 3-lobed, with a lobe on each side near the middle, 3-nerved, spotted with purple or magenta or in albino forms without spots, 7-8 mm. long, about

4 mm. broad; capsule ovoid.—Woods. Throughout our range. Across the continent in temperate latitudes and south to Central America.

3. *C. Wisteriana*³ Conrad in Journ. Acad. Nat. Sci. Phila. 6: 145. 1829.

Plant 1.5-4 dm. tall, the stems purple or yellow. Sepals and petals lanceolate, 5-7 mm. long, 1-2 mm. broad; lip oval or suborbicular, entire, or erose-denticulate, white spotted with purple, 4-6 mm. long.—Woods. Colorado. Eastward.

4. *C. trifida* (L.) Chatelain, Spec. Inaug. Corallorhiza 8. 1760.

Ophrys corallorhiza L., Sp. Pl. ed. 1. 2:945. 1753.

Corallorhiza innata R. Br. in Ait., Hort. Kew. ed. 2. 5:209. 1813.

C. Corallorhiza Karsten, Deutsche Fl. Pharm.-med. Bot. 448, fig. 264. 1883.

C. Corallorhiza var. *coloradensis* Ckll. in Torrey 16:321. 1916.

C. wyomingensis C. E. & K. J. Hellm. in Rhodora 33:133. 1931.

Plant slender, 6-25 cm. tall, the stem yellow, 4-16-flowered. Sepals and petals linear, about 6 mm. long and 1 mm. broad; lip white, not spotted, with a curved tooth on each side above the base, about 5 mm. long and 2-3 mm. broad; spur very short or none; capsule ovoid to ellipsoid.—Moist woods. British Columbia to Colorado and Idaho. Northward and eastward. Eurasia.

5. *C. Mertensiana* Bong. in Mem. Acad. Imp. Sci. St. Peter. Ser. 6. 2: 165. 1832.

C. purpurea L. Wms. in Bull. Torr. Bot. Club 59:427. 1932.

Plant slender, 1.5-4 dm. tall, the stem purple, 10-20-flowered. Sepals and petals linear-lanceolate, about 8 mm. long and 1.5-2 mm. broad; lip oblong, obtuse, with a curved tooth on each side or rarely entire, usually somewhat serrated; spur about 1 mm. long.—Occasional in woods. British Columbia to Wyoming and Idaho. Westward and northward.

³ The two specimens of this species seen, McKelvey 4682 and 4708, La Plata Co., Colorado, may be only forms of *C. maculata* but they seem to have the characters of *C. Wisteriana*. Mr. Charles Schweinfurth considers them to belong to the latter species.

Studies in Mexican and Central American Plants

Cornelius H. Muller¹

I. A new *Ulmus* from Coahuila, Mexico

The author encountered several trees of an apparently new *Ulmus* growing in a moist canyon in the mountains of northern Coahuila. The locality has an altitude of probably four or five thousand feet. The twig and foliage characters of the new material can hardly be used to distinguish it from *Ulmus divaricata* C. H. Mull.² which occurs in similar habitats in central Nuevo Leon and has a similar habit. The trees observed in Coahuila were all barren of flowers and fruit at the time, but a single fallen fruit and some peduncles were found after a tedious search in debris-filled crevices. The differences exhibited by this single fruit (Fig. 1, B) are so profound that it is difficult to imagine that they might have arisen as the result of pathology, simple mutation, or ecological variation. The more numerous available fruits of *U. divaricata* exhibit a normal variation in form (e.g., about ten percent of the fruits have erect style branches rather than divergent ones), but in no case is the disposition of the principal veins and reticulum noticeably different from the illustration (Fig. 1, A) or in any way similar to the material here described as a new species.

Ulmus multinervosa sp. nov.

Twigs round, very slender (0.6-1 mm.), reddish-brown, loosely silky-hairy, becoming glabrous the second year with a few light tan, inconspicuous lenticels. Buds red-brown, elongate-conic, very acute, about 0.8-1 x scarcely 2 mm., glabrous, with the narrow membranous strap-like stipules soon deciduous. Leaves moderately small (1.3-5 x 2.5-8, usually about 1.8 x 4.5, cm.), lanceolate to usually broad-lanceolate, twice serrate with acute teeth hardly incurved and lightly mucronate, unequilaterally cordate at the base, the base always quite narrowed so as to appear coarsely acute, the apex typically long attenuate, the two surfaces roughened with short stiff hairs, those on the upper surface readily visible to the naked eye by reason of their broad blister-like bases, lower surface minutely papillose between the hairs, midrib above and both veins and midrib beneath clothed in long silky hairs; midrib and veins slightly impressed above and prominent beneath; petiole short (2-4, usually 3, mm. long; 0.6-1 mm. thick), greenish ivory in color beneath, brown like the twigs above, densely soft hairy like the midrib. Flowers?

¹ Previously spelled "Mueller" in signing papers in Torreya, Bull. Torr. Bot. Club, and Jour. Arn. Arb.

² Mueller, C. H., "New and noteworthy trees in Texas and Mexico," Bull. Torr. Bot. Club 63:147. 1936.

Fruits about 3-5 on pedicels 1 mm. long scattered on a peduncle about 10-12 mm. long; samaras small (about 2.5 x 4 mm.), glabrous, narrowly ovate with style branches apparently erect, one prominent central vein with two lesser lateral ones giving rise to numerous (50-60) small parallel veinlets perpendicular to the margin forming a compact reticulum.

Ramuli 0.6-1 mm., fusci, sparse sericei; gemmae fuscae elongato-conicae, 0.8-1 x vix 2 mm., glabrae; folia mediocria (1-3.5 x 2.5-8, plerumque circa 1.8 x 4.5 cm.), lanceolata, plerumque late lanceolata, duplicati-serrata, basi inaequaliter cordata atque semper valde angustata ut videtur crasse acuta, apice elongato-attenuata, utrinque pilis brevibus rigidis asperata; supra costa nervique impressi subtusque prominentes; petiolus 0.6-1 x 2-4 mm.; fructus circa 3-5 pedicellis 1 mm. longis pedunculo 10-12 mm. longo dissitis; samarae glabrae 2.5 x 4 mm., anguste ovatae, ramis styli ut videtur erectis, nervulis 50-60 a nervo centrali atque nervis duobus lateralibus ortis reticulum compactum formantibus.

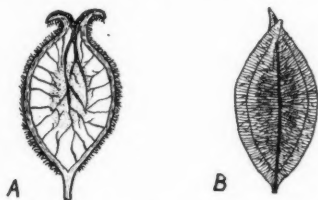


Fig. 1. A, Samara of *Ulmus divaricata* (x 6);
B, Samara of *U. multinervosa* (x 6).

Mexico: Coahuila, Municipio de Muzquiz, Rancho Agua Dulce, "wooded canyon on the east slope of Sierra de San Manuel," Wynd & Muller no. 338, June 28, 1936 (type in the herbarium of the University of Illinois).

This species occurs as a small or moderate tree (up to .25 x 15 m.) with its irregularly rounded crown high on the slender trunk giving much the same appearance as young trees of *Ulmus americana* L. when the latter species grows in densely shaded habitats. *U. multinervosa* was not observed in open situations.

The leaves of this species are more noticeably narrowed basally than those of *U. divaricata*. The greatest differences, however, lie in the glabrous samara of *U. multinervosa*, with its unique veining and margins not thickened, on pedicels only 1 mm. long.

II. Studies in the oaks of the mountains of Coahuila, Mexico

In June and July of 1936 the author was privileged to make a collection of plants in Mexico with Dr. F. L. Wynd. In the five weeks in the field the party traversed the state of Coahuila from southeast to northwest and touched frequently on the series of mountain ranges which lie along the route. The habitat conditions induced by rough topography and higher elevation proved favorable for the development of forests in what is otherwise a desert plain.

The area covered lies between the Chisos Mountains, Texas (studied in

1931, 1932, and 1933) and the Sierra Madre Oriental in the state of Nuevo Leon (studied in 1933, 1934, and 1935)³, thus completing a preliminary survey of a 400 mile series of almost continuous mountain ranges.

The author was fortunate in obtaining for study the oaks collected in northern Coahuila by Mr. Ernest Marsh during the summer of 1936. For this kindness the author is greatly indebted to Dr. B. C. Tharp and Mr. Marsh, both of the University of Texas.

The types of the new species herein described are deposited in the herbarium of the University of Illinois.

Subgenus LEUCOBALANUS Engelmnn

Series POLYMORPHAE Trelease

Quercus porphyrogenita Trelease in Mem. Nat. Acad. Sci. 20: 51 (1924).

Q. microlepis Trel. & Mull. in Bull. Torr. Bot. Club 63:150 (1936).

Q. glaucophylla von Seemen var. et f. Mull. in Bull. Torr. Bot. Club 63:150 (1936) & in Jour. Arn. Arb. 17:162-163 (1936).

The various forms herein included were regarded as distinct on the basis of the profound variation exhibited, but a comparison of Coahuilan material with that of Nuevo Leon has brought out the integrated nature of the group of forms. *Q. microlepis* is none other than the typical form of *Q. porphyrogenita*; it comes from the type locality of that species and exhibits all its morphological characters. This author can no longer agree to its distinctness. The forms named under *Q. glaucophylla* do show some differences which distinguish them from *Q. porphyrogenita*, but hardly enough to outweigh the evidence of intergrades which are quite as numerous as the extremes.

This species like many others shows two types of variation: within any sizeable local population may be found most of the forms known in the species; some local populations exhibit a character peculiar to that locality only. It is to this latter class that typical *Q. porphyrogenita* belongs. The outlying localities, both to the north and to the south, contain the more variable forms. There are, however, a few other locally characteristic forms. The designation of *Q. porphyrogenita* or any other single form as the type of this complex must be done with reservations. The form names applied under *Q. glaucophylla* may be retained under *Q. porphyrogenita*, but they have little or no geographic or phylogenetic significance. They are *f. macropetiolata*, *f. subrotundifolia*, *f. lobata*, and *f. longifolia*.

The great variability of this species and that of *Q. breviloba* (Torr.) Sarg. (discussed below) have, by reason of some superficial likenesses, made their distinction a little difficult in cases of immature specimens and the like.

3 Mueller, C. H., "Some new oaks from Western Texas," *Torreya* 34:119-122. 1934.

Mueller, C. H., "New and noteworthy trees in Texas and Mexico," *Bull. Torr. Bot. Club* 63:147-155. 1936.

Mueller, C. H., "Studies in the oaks of the mountains of Northeastern Mexico," *Jour. Arn. Arb.* 17:160-179. 1936.

It is not the author's purpose to suggest that they are identical or even closely related, but merely to point out the rareness of *Q. breviloba* in Mexico and the abundance of *Q. porphyrogenita* f. *lobata* and others which resemble *Q. breviloba*.

Coahuila: Mun. de Castaños: northwest slopes of Sierra San Lázaro. Wynd & Muller no. 170, June 18, 1936;—Mun. de Muzquiz: Sorpresa Spring, Marsh no. 335, July 8, 1936, and no. 344, July 9, 1936; Murquiz, Marsh no. 368, July 9, 1936; Rancho Agua Dulce, wooded canyon on east slope of Sierra San Manuel, Wynd & Muller nos. 345 & 346, June 28, 1936;—Mun. de Villa Acuña: Sierra del Carmen, Cañón de Sentenela on Hacienda Piedra Blanca, moist stream side, Wynd & Muller nos. 541 & 617, July 6, 1936.

Series RETICULATAE Trelease

Quercus diversicolor Trelease in Mem. Nat. Acad. Sci. 20: 73 (1924).

Coahuila: Mun. de Villa Acuña: Sierra del Carmen, Marsh no. 829, September 12, 1936; Sierra del Carmen, Cañón de Sentenela on Hacienda Piedra Blanca, high slope with northwest exposure, Wynd & Muller nos. 634, 636, & 641, July 9, 1936.

Series INTRICATAE Trelease

Quercus intricata Trelease in Mem. Nat. Acad. Sci. 20: 84 (1924).

Coahuila: Mun. de Castaños: rocky slopes of Puerto de San Lázaro, Wynd & Muller no. 163, June 17, 1936.

Series INVAGINATAE Trelease

Quercus invaginata Trelease in Mem. Nat. Acad. Sci. 20: 87 (1924).

Coahuila: Mun. de Castaños: rocky slopes of Puerto de San Lázaro, Wynd & Muller no. 138, June 16, 1936.

With the species in the same locality was found f. *Purpusiana* Trel. (l.c.), Wynd & Muller no. 162, June 17, 1936. This locality name is synonymous with "Sierra de la Paila" given by Trelease as the type locality of both the species and the form.

Series ARIZONICAE Trelease

Quercus Mohriana Buckley in Rydberg, Bull. N. Y. Bot. Gard. 2: 219 (1901).

Coahuila: Mun. de Muzquiz: Hacienda Mariposa, ravine near Puerto Santa Ana, Wynd & Muller no. 232, June 22, 1936; Hacienda La Rosita, Wynd & Muller no. 306, June 26, 1936; Rancho Agua Dulce, lower slopes of Sierra de San Manuel, Wynd & Muller no. 307, June 27, 1936; Muzquiz, Sorpresa spring, Marsh no. 336, July 8, 1936; Palm Canyon, Marsh no. 373, July 9, 1936;—Mun. de Villa Acuña, open slopes about Santo Domingo, Wynd & Muller no. 451, July 3, 1936, & no. 483, July 4, 1936; Sierra del Carmen, Marsh no. 854, September 9, 1936.

Series GRISEAE Trelease

Quercus grisea Liebmann in Overs. Dansk. Vidensk. Selsk. Forhandl. p. 171 (1854).

Coahuila: Mun. de Villa Acuña: Sierra del Carmen, *Marsh no. 832*, September 12, 1936.

Quercus endemica sp. nov.

Twigs slender (1-2 mm.), fluted, densely clothed in yellow tomentum which persists to some degree the second or even third year, brown when abraded. Buds round, 1-1.5 mm., tomentose like the stem and finally glabrate and brown; awl-like stipules 4-7 mm. long, quickly caducous, sparingly hairy on the outer surface. Leaves deciduous, oblong, usually 3 x 8 cm. (occasionally 1.5 x 5 to 4 x 9 cm.), entire or slightly undulate or dentate above (serrate with mucronate tips in one form), apex usually rounded, sometimes acute, base rounded (infrequently cordate or cuneate), upper surface glossy, sparingly soft short-stellate, lower surface more densely so; veins 9-12 x 2, much branched and looping, ultimately passing into the teeth when those are present, midrib slightly raised above, all veins quite prominent and reticulate beneath; petioles 1 x 4-12 (usually 8) mm., densely soft yellow-stellate. Pistillate catkins 10-20 or 40 mm., 1-3 (rarely more) flowers on a densely stellate peduncle. Fruit usually two, one terminal and one lateral on a hoary peduncle 1-1.5 x 20-40 mm.; cups deep cup-shaped, 6-8 mm. deep and 8-10 mm. broad, scales appressed, basally swollen and pruinose, the apices sparingly fleecy and finally rounded; acorns (immature) ovoid, about 7 x 9 mm., glabrous save the apex, about two-thirds included.

Ramuli 1-2 mm. crassi, dense flavo-tomentosi; gemmae rotundae 1-1.5 mm. tomentosae; stipulae 4-7 mm. longae mox caducae; folia decidua oblonga 3 x 8 cm. integra vel undulata vel dentata, apice basique rotundata, supra nitida sparse subtus densius stellato-pubescentia; venis utrinque 9-12 valde prominentibus; petioli 1 x 4-12 mm. dense flavo-stellato-pubescentes; fructus bini, pedunculo 1-1.5 x 20-40 mm. stellato-piloso, cupula 6-8 x 8-10 mm., squamae incanae, glans 7 x 9 mm. $\frac{2}{3}$ cincta.

Coahuila: Mun. de Villa Acuña: Sierra del Carmen, Cañón de Sentenela on Hacienda Piedra Blanca, high slope with northwest exposure, *Wynd & Muller no. 638* (type), July 9, 1936, and, on a moist stream side, *nos. 540 & 565*, July 6, 1936.

Texas: Chisos Mountains: about Boot Spring, *Muller (without no.)*, June 30, 1932; in Pine Canyon, *Muller (without no.)*, August 20, 1933.

This species occurs abundantly as a small tree of 6-10 m. in open pine forest where with *Quercus hypoleuca* Engelm. it forms an understory. Its relationship to *Q. grisea* Liebm. is obvious in the intergrades which occur with the Texas specimens. The larger, more reticulate and elongate leaves are apparently constant key characters which distinguish it from *Q. grisea*.

Series UNDULATAE Trelease

Quercus undulata Torr. var. *Vaseyana* Rydberg in Bull. N. Y. Bot. Gard. 2: 218 (1901).

Q. sillae Trelease in Mem. Nat. Acad. Sci. 20:102 (1924).

Coahuila: Mun. de Villa Acuña: Sierra del Carmen, *Marsh no. 870*, September 2, 1936.

This collection together with those of the author in Nuevo Leon and in the Chisos Mountains of Texas rather definitely demonstrate the identity of *Q. sillae* Trel. with this variety.⁴ They represent a relatively continuous series bearing identical morphological forms.

Series GAMBELIAE Trelease

Quercus carmenensis sp. nov.

Twigs slender (1-1.5 mm.), slightly fluted, reddish-brown and sparingly stellate with a few pale, small but prominent lenticels, becoming gray and glabrous the second year with lenticels less contrasting. Buds round, about 1 mm. in diameter, light brown and somewhat hairy, with persistent awl-like stipules about 4-6 mm. long quite hairy on the flattened outer surface. Leaves oblong to oblanceolate, about 1-2 x 3-5 cm., the bases acute, cuneate, or rarely somewhat rounded, the apices roughly acute, the ultimate rounded tip slightly mucronate, the margin entire, undulate, or coarsely mucronately round-dentate near the apex, upper surface dark green, glossy though covered with short, soft stellate hairs, lower surface lighter, more densely yellow-stellate; veins prominent, especially beneath, about 9-12 x 2, much branched and looping though ultimately passing into the mucronations of lobes where those are present; petioles about 5-10 mm. long, stellately pubescent especially on the upper surface but finally glabrate, bases red like the twigs. Catkins? Fruit solitary or paired, sessile, immature cups with acute, light brown, pubescent scales; acorns?

Ramuli 1-1.5 mm. crassi sparse stellato-tomentosi; gemmae rotundae 1 mm. crassae; stipulae subulatae 4-6 mm. longae; folia decidua oblanceolata 1-2 x 3-5 cm., basi et apice acuta vel rotundata, integra vel undulata vel apicem versus crasse dentata, supra nitida atque stellata, subtus densius flavo-stellata; venis subtus prominentibus utrinque 9-12; petioli 5-10 mm. longi stellato-pubescentes, demum glabrescentes; fructus solitarii vel bini, sessiles, cupula immatura squamis acutis pruinosis.

Coahuila: Mun. de Villa Acuña: Sierra del Carmen, Cañón de Sentenela on Hacienda Piedra Blanca, high slope with northwest exposure, *Wynd & Muller no. 639* (type), July 9, 1936.

This species occurs sparsely on a steep talus slope as a low, almost procumbent shrub 1-2 m. tall. Its assignment to this series is made with hesitancy, for it exhibits characters much unlike other species in the group. Perhaps further study in adjacent areas will reveal another series of which this species is a member. If such is the case, the new series will be very similar to the series *Gambeliae*, for the characters of this form link it definitely with other gambeloid oaks, e.g., the next following species.

An outstanding character of *Q. carmenensis* is the bright redness in many instances of the twigs and petioles which is quite noticeable at distances of ten to twenty feet. This character is practically lost in drying.

⁴ Mueller, C. H., Jour. Arn. Arb. 17:168. 1936.

Quercus Marshii sp. nov.

Twigs slender (1-2 mm.), fluted, dark brown with small conspicuous lenticels, sparingly coarse-hairy or nearly glabrous, becoming grayish and quite glabrous with lenticels less salient the second year. Buds acute-ovoid, 2 x 3-4 mm., scales brown and glabrous; leaf stipules awl-like (about 4-5 mm. long), those of the buds lanceolate to triangular or much broadened basally (about 2-2.5 mm. long), both types quite hairy on the outer surfaces. Leaves deciduous, about 3.5 x 6.9 cm., narrowly ovate in outline, deeply incised (3-5, usually 4, sinuses on each side) to form rounded (sometimes cuneate), entire, or rarely undulate lobes forming an angle of 45° or greater with the midrib, or in xeric forms shallowly incised by fewer sinuses, unequilaterally rounded or rounded and finally acute or cuneate at the base, upper surface dark green and glossy, sparingly clothed with simple and stellate soft short hairs, the lower surface dull, lighter in color, rather densely soft-hairy especially on the midrib and principal veins; veins one in each lobe with one or two intermediates, slightly raised above and quite prominent and light in color beneath; petioles about 1 x 10 to rarely 15 mm., densely soft stellate-pubescent. Catkins? Fruit solitary or paired, sessile; immature cups round, the scales lanceolate, only slightly thickened basally, thickened part dark brown and sparsely white pubescent, the thin margins light brown and glabrous; acorns?

Ramuli 1-2 mm. crassi sparse hirti vel glabrati; gemmae acuto-ovoideae 2 x 3-4 mm. squamis glabris; folia decidua 3.5 x 6-9 cm. anguste ovata profunde incisa lobis utrinque 3-5 rotundis vel cuneatis, basi rotundata vel cuneata, supra nitida sparse subtus dense stellato-pubescentia; venis subtus prominentibus; petioli 1 x 10 vel 15 mm. dense stellato-pubescentes; fructus solitarii vel bini sessiles, cupula immatura rotundata squamis lanceolatis basi pruinosis.

Coahuila: Mun. de Villa Acuña: Sierra del Carmen, Cañón de Sentenela on Hacienda Piedra Blanca, high slope with northwest exposure, Wynd & Muller nos. 640 (type), 633, & 635, July 9, 1936; Sierra del Carmen, Marsh no. 823, September 12, 1936.

This species occurs in small numbers in very isolated areas at high altitudes where it is a shrub 3-4 m. in height. It is most closely related to *Q. Gambelii* Nutt. Of the latter species Nuttall⁵ writes, "... leaves . . . , beneath pubescent . . . "; Rydberg⁶, "... upper surface glabrate, green, not very glossy; lower surface only slightly paler, puberulent or nearly glabrous, . . . "; Greene⁷, "... leaves glabrous . . . ". *Q. Marshii* with both surfaces exceedingly velvety to the touch can hardly fit any of these contradictory descriptions.

The series *Gambelieae* is in large part confined to mountainous areas farther north. Southern outposts of several species have a distribution characterized by confinement to the highest peaks and by a consequent high degree of isolation.

⁵ Nuttall in Jour. Phil. Acad. n.s. 1:179. 1848.

⁶ Rydberg in Bull. N. Y. Bot. Gard. 2:210. 1901.

⁷ Greene in Ill. West. Am. Oaks p. 23. 1889.

Series DURANDIEAE Trelease

Quercus breviloba (Torr.) Sargent in Garden & Forest 8: 93 (1895).

Coahuila: Mun. de Muzquiz: Rancho Agua Dulce, lower slopes of Sierra de San Manuel, Wynd & Muller nos. 308, 309, & 311, June 27, 1936; wooded canyon on east slope of Sierra de San Manuel, Wynd & Muller nos. 342 & 344, June 28, 1936.

This series of five collections represents more variations than can comfortably be referred to one so-called species, but in a case of this sort in which all the collections are made in what is obviously a small interbreeding population, any attempt to distinguish this group from those north and east of the boundary region without an extensive study of the forms of the intervening areas, if such forms exist, would be unwise even though it is entirely possible that two species are involved.

Series PRINOIDEAE Trelease

Quercus Brayi Small in Bull. Torr. Bot. Club 28: 558 (1901).

Coahuila: Mun. de Muzquiz: Rancho Agua Dulce, Wooded canyon on east slope of Sierra San Manuel, Wynd & Muller no. 347, June 28, 1936.

Quercus sentenelensis sp. nov.

Twigs slender (1.5-3 mm.), light brown, fluted, glabrous or very sparingly soft-hairy, becoming gray with a few inconspicuous lenticels the third year. Buds ovoid, reaching 2.5 mm. in diameter, scales reddish-brown, slightly hoary with short, irregular hairs; strap-like stipules 2-3 mm. long, sparsely hairy, persistent at the terminal bud. Leaves deciduous, small for the group, blades about 3.5 x 6.5 to 7 x 12 cm., broadly obovate, the margins crenate with about nine usually rounded, mucronate lobes on each side, apex obtuse or acute, the apical lobe rounded, base obtuse or cuneate, upper surface somewhat glossy, dark green, very sparingly simple- and stellate-hairy, lower surface dull, light green, densely covered with soft, inconspicuous simple and stellate hairs; veins about 9 x 2, slightly raised on both surfaces, each terminating in a mucronate lobe, the ultimate reticulum raised; petioles slender, about 1 x 15-30 mm. Flower and fruit?

Ramuli 1.5-3 mm. crassi glabrati vel sparsissime pilosi; gemmae ovoideae 2.5 mm. crassae; stipulae lorae 2-3 mm. longae sparse tomentosae; folia decidua 3.5-7 x 6.5-12 cm. late obovata crenata, apice obtusa vel acuta, basi obtusa vel cuneata, supra nitida sparsissime stellata, subtus dense stellato-pubescentia; venis utrinque 9 supra subtusque prominulis; petioli 1 x 15-30 mm.

Coahuila: Mun. de Villa Acuña: Sierra del Carmen, Cañón de Sentenela on Hacienda Piedra Blanca, moist stream side, Wynd & Muller no. 629 (type), July 9, 1936.

A shrub or small tree of 3-6 m. with the habit and trembling leaves (though not quite so pendent) of young quaking aspen, this species occurs sparsely in the dense pine and oak wood of a high canyon. It is obviously a member of the series *Prinoideae*, but it cannot be assigned any very close

relationship to any species known. The densely soft-hairy leaves with broad blades and the lack of evident lenticels until the third year definitely set off this species from both juvenile and mature forms of *Q. Brayi* Small.

Series VIRENTES Trelease

Quercus fusiformis Small in Bull. Torr. Bot. Club 28: 357 (1901).

Coahuila: Mun. de Muzquiz: highway between Muzquiz and Hacienda Mariposa, *Wynd & Muller* no. 285, June 26, 1936; Muzquiz, "Santa Ana Canyon" [Puerto Santa Ana], *Marsh* no. 518, July 15, 1936.

Subgenus ERYTHROBALANUS Oersted

Series HYPOLEUCAE Trelease

Quercus hypoleuca Engelm in Tran. Acad. Sci. St. Louis 3: 384 (1876).

Coahuila: Mun. de Villa Acuña: Sierra del Carmen, Cañón de Sentenela on Hacienda Piedra Blanca, moist stream side, *Wynd & Muller* nos. 533 & 564, July 6, 1936; same locality, high slope with northwest exposure, *Wynd & Muller* no. 637, July 9, 1936; Del Carmen Mountains, *Marsh* no. 831, September 12, 1936.

Series COCCINEAE Trelease

Quercus chesosensis (Sarg.) comb. nov.

Q. texana Buckley var. *chosensis* Sargent in Bot. Gaz. 65:423 (1918).

Q. coccinea Muench. var. *microcarpa* Torrey in Rep. U. S. & Mex. Bound. Surv. 2:206 (1859).

Q. Gravesii Sudworth in U.S.D.A. Misc. Circular 92:86 (1927).

Coahuila: Mun. de Castaños: northeast slopes of Sierra San Lázaro, *Wynd & Muller* no. 171, June 18, 1936;—Mun. de Muzquiz: Hacienda Mariposa, ravine near Puerto Santa Ana, *Wynd & Muller* no. 234, June 22, 1936; Muzquiz, Sorpresa Spring, *Marsh* no. 337, July 9, 1936; Muzquiz, Palm Canyon, *Marsh* no. 369, July 9, 1936; Rancho Agua Dulce, lower slopes of Sierra San Manuel, *Wynd & Muller* no. 330, June 27, 1936; moist wooded canyon on the east slope of Sierra San Manuel, *Wynd & Muller* no. 383, June 30, 1936;—Mun. de Villa Acuña: open country between Rancho Santo Domingo and Hacienda Piedra Blanca, *Wynd & Muller* no. 493, July 4, 1936; near Piedra Blanca on igneous hills, *Wynd & Muller* no. 500, July 4, 1936; Sierra del Carmen, Cañón de Sentenela on Hacienda Piedra Blanca, moist stream side, *Wynd & Muller* no. 534, July 6, 1936, nos. 600 & 608, July 8, 1936; same locality, dry open country near mouth of the canyon, *Wynd & Muller* no. 651, July 10, 1936; Sierra del Carmen, *Marsh* no. 591, August 26, 1936; Sierra del Carmen, Jardín del Sur, *Marsh* no. 768, September 3, 1936.

Detailed field study of this species in the Chisos Mountains, Texas, several years ago suggested its specific rank. Further study in the southern extremities of its range has upheld the earlier conclusion. In the writing of

this paper it came to the author's attention that Sudworth had already raised the variety to specific rank on the basis of a study of Texas material. Unfortunately, Sudworth did not preserve the name first proposed by Sargent but gave it another, *Q. Gravesii*, which appears to be an unnecessary change and not in accordance with any code. It therefore seems best to re-instate Sargent's name. Sargent misspelled the name of the locality after which he named the variety; this explains the discrepancy in the spellings of "chesosensis" and "Chisos," the type locality.

III. Notes on some oaks of Guatemala

Through the courtesy of the United States National Herbarium, the Arnold Arboretum, and Dr. Wm. Trelease of the University of Illinois, the author received for study thirty-five numbers of oaks collected in southwestern Guatemala by Dr. A. F. Skutch. The collections were made in March and November of 1933 and in August, September, November, and December of 1934. They represent nine of the twenty-seven known Guatemalan species as well as two apparently undescribed species and two species hitherto not reported from Guatemala.

Most of the forms could be referred to previously known species of which, in some cases, they represent aberrants of greater or lesser degree. Where the variation deviates from the type sufficiently to be confusing if the whole be regarded as a simple species, a form name has been applied. This seems the only way to deal with a few of the more polymorphic species some of which, unfortunately, include more variation than exists between some aspecific groups. This is especially true of the first group here discussed.

In citing the type specimens United States National Herbarium is abbreviated to U.S., and the Herbarium of the University of Illinois to Ill.

Subgenus LEUCOBALANUS Engelmänn

Series PEDUNCULARES Trelease

Quercus pilicaulis Trelease in Mem. Nat. Acad. Sci. 20: 67 (1924).

Guatemala: Depto. de Chimaltenango: altitudes ranging from 8200 to 8400 feet at Chichavac, *Skutch nos.* 684, 686, 688, and 728;—Depto. de Huehuetenango: 8200 feet altitude at San Juan Ixcay, *Skutch nos.* 1076 & 1078.

concava f. nov.

Differs from the type only in the leaves very concave beneath and larger (about 8 x 19 cm.).

A planta typica foliis subtus valde concavis et majoribus (circa 8 x 19 cm.) differt.

Guatemala: Depto. de Chimaltenango: 8200 feet altitude at Chichavac, *Skutch no.* 685 (type in U.S. no. 1587690); Depto. de Huehuetenango, 8000 feet altitude at San Juan Ixcay, *Skutch no.* 1072.

elongata f. nov.

Leaves mucronately and coarsely toothed, the margins roughly undulate; peduncles elongate, 1.5-2 x 120 or 130 mm., cups deep and with scales

rather densely tomentose like the type; acorn long-conic, acute, 10-12 x 20-30 mm., coarsely grooved longitudinally, nearly half included.

Folia mucronato-dentata vel serrata, marginibus undulatis; pedunculi 1.5-2 x 120 vel 130 mm.; cupula alta; glans longe conica, acuta, 10-12 x 20-30 mm., longitudinaliter crasse striata, fere semi-cincta.

Guatemala: Depto. de Chimaltenango: 8200 feet altitude at Chichavac, *Skutch no. 687* (type in U.S. no. 1587692).

exserta f. nov.

Leaves typical, peduncles very slender (1.5 x 50-70 mm.), cups small and shallow (9-12 mm. broad, 3-4 mm. deep), the scales but scantily short-hairy; acorns long-conic, acute, 9-12 x 20-28 mm., covered at the base only.

Folia typica; pedunculi 1.5 x 50-70 mm.; cupulae 9-12 mm. latae, 3-4 mm. altae squamis sed sparse pilosis; glans longe subconica, acuta, 9-12 x 20-28 mm., basi olim cincta.

Guatemala: Depto. de Chimaltenango: 8300 feet altitude at Chichavac, *Skutch no. 661* (type in U.S. no. 1587664).

Subgenus ERYTHROBALANUS Oersted

Series CRASSIFOLIAE Trelease

Quercus Skutchii Trelease in Jour. Wash. Acad. Sci. 23: 62 (1933).

Guatemala: Depto. de Chimaltenango: 8200 feet altitude at Chichavac, *Skutch no. 727*;—Depto. de Huehuetenango: 8000 feet altitude at San Juan Ixcay, *Skutch nos. 1068 & 1075*;—Depto. de Quiché: 6300 feet altitude at Nebaj, *Skutch no. 1653*.

Quercus chichavacana Trelease in Jour. Wash. Acad. Sci. 23: 62 (1933).

Guatemala: Depto. de Chimaltenango: 8300 feet altitude at Chichavac, *Skutch no. 682*.

undulata f. nov.

Leaves somewhat elongated (2.5-3.5 x 8-10 cm.), acute to mucronately obtuse, the margin slightly revolute, undulate, and sometimes shouldered near the apex, but not serrate.

Folia ± elongata, acuta vel mucronato-obtusata, margine leviter revoluta, undulata.

Guatemala: Depto. de Chimaltenango: 8200 feet altitude at Chichavac, *Skutch no. 689* (type in U.S. no. 1587694).

sublobata f. nov.

Similar to f. *undulata* but the leaves broader (usually 4.5-6 x 11-14 cm.), consistently obtuse, the margin shallowly round-lobed, some of the lobes aristate.

F. undulata similis, sed foliis latioribus (4.5-6 x 11-14 cm.) semper obtusis, margine leviter rotundato-lobata quibusque lobis aristatis.

Guatemala: Depto. de Chimaltenango: 8300 feet altitude at Chichavac, *Skutch no. 712* (type in Ill.).

oblanceolata f. nov.

Differs from f. *undulata* in its leaves broadened upwards (4-6.5 x 9-15

cm.), narrowed basally, finally cuneate or rounded, rarely shouldered and aristate upward.

A f. *undulata* foliis apicem versus dilatatis (4-6.5 x 9-15 cm.) atque aristatis, basin versus attenuatis, basi cuneatis vel rotundatis, rare carinatis differt.

Guatemala: Depto. de Chimaltenango: 8300 feet altitude at Chichavac, *Skutch no.* 681 (type in U.S. no. 1587686).

Series ARISTATAE Trelease

Quercus exaristata Trelease in Mem. Nat. Acad. Sci. 20: 140 (1924).

Guatemala: Depto. de Quiché: 7500 feet altitude at Nebaj, *Skutch no.* 1906.

Series BENTHAMIAE Trelease

Quercus aff. *Tonduzii* von Seemen Bull. Herb. Boissier, ser. 2, 4: 656 (1904).

Guatemala: Depto. de Huehuetenango: 9400 feet altitude at San Juan Atitan, *Skutch no.* 1155;—Depto. de Totonicapam: 10000 feet altitude at Cumbre del Aire, *Skutch no.* 1278.

This species is known definitely only from the type collection in Costa Rica. This material collected at a considerable distance and beyond a natural barrier from the type locality might well prove to be a distinct species upon examination of complete specimens.

Series PARVIGLANDES Trelease

Quercus gemmata Trelease in Mem. Nat. Acad. Sci. 20: 152 (1924).

Guatemala: Depto. de Chimaltenango: 8300 feet altitude at Chichavac, *Skutch no.* 693 with the midribs and larger veins rather persistently heavily rufous stellate-hairy, *no.* 692 and a duplicate of *no.* 693 with tomentum largely shed or reduced to axillary tufts represent a variation which, by reason of its ephemeral nature, may best be regarded as an amplification of the type rather than a distinct form.

Series ACATENANGENSES Trelease

Quercus Donnell-Smithii Trelease in Mem. Nat. Acad. Sci. 20: 162 (1924).

Guatemala: Depto. de Chimaltenango: 8200 feet altitude at Chichavac, *Skutch no.* 691.

Series SKINNERIAE Trelease

Quercus hemipteroides sp. nov.

Glabrous. Twigs about 3 mm., shallowly fluted, dark reddish with a light gray bloom, lenticels small, raised, light. Buds oblong, about 3.5 x 8 mm., acute, the apex hairy. Leaves deciduous, rather large (4.5-9 x 11-18 cm.), ovate to rarely broadly lanceolate, acute, unequilaterally rounded to subcordate at the base, the margins shallowly serrate with long-aristate teeth, both surfaces dark green; veins about 10 or 12 x 2, prominent on both surfaces, especially below, forking and indistinctly looping but invariably passing

into the teeth; petiole about 1 x 30-35 mm., dark red at the base. Pistillate catkins 1-flowered, about 5 mm. long. Fruit biennial, solitary, subsessile, extremely large; cup shallow (about 45 mm. broad and 15 mm. deep), the scales peculiarly thickened, wrinkled, and dark brown at the base subtending the membranous, light brown, rounded or acute apex; acorn subcylindric, as broad as long (40 mm.), truncate at the base, abruptly rounded at the top, enclosed only at the base.

Glabra; ramuli 3 mm. crassi, atropurpurei, cinereo-glaucoscentes; lenticellae parvae, elevatae, dilutae; gemmae oblongae (3.5 x 8 mm.), acutae, apice pilosae; folia decidua, 4.5-9 x 11-18 cm., ovata vel rare lato-lanceolata, acuta, basi inaequaliter rotundata vel subcordata, margine leviter serrata dentibus longe aristatis; nervis circa 10 vel 12 x 2, utrinque valde prominentibus, regulariter in dentes desinentibus; petioli fere 1 x 30-35 mm.; amenta ♀ uniflora, fere 5 mm. longa; fructus biennis, solus, subsessilis, magna; cupula fere 45 mm. lata et 15 mm. alta, squamis basi peculiariter incrassatis, rugosis, brunneis, apicem fusco-membranaceum rotundatum vel acutum fulcrantibus; glans subcylindrica, aequilateralis (40 x 40 mm.), basi truncata, apice subito rotundata, basi solum cincta.

Guatemala: Depto. de Quiché: 3900 feet altitude at Finca San Francisco, *Skutch no. 1875* (type in Ill.).

A large tree, 120 feet high, the trunk 6 feet in diameter above the buttressed base, fluted, with moderately rough bark, this species occurs as a relict on cut-over land. It may be distinguished from *Q. Skinneri* Benth., to which it is most closely related, by its more numerous veins and correspondingly more numerous teeth with much more shallow sinuses and by its elongate buds. The name is intended to call attention to the nature of the cup scales which are like the wings of the insect order *Hemiptera*.

Series MEXICANAE Trelease

Quercus subcrispata Trelease in Mem. Nat. Acad. Sci. 20: 176 (1924).

Guatemala: Depto. de Huehuetenango: 6600 feet altitude, *Skutch no. 1105*.

Series ACUTIFOLIAE Trelease

Quercus conspersa Benth in Plant. Hartweg. p. 92 (1842).

Guatemala: Depto. de Huehuetenango: 7000 feet altitude, *Skutch no. 1133*;—Depto. de Chimaltenango: at Chichavac, *Skutch no. 315* is a juvenile specimen with the not yet fully developed leaves relatively broader and more unequilaterally lobed, but its distinction as a form is uncertain with such immature material in such a polymorphic species.

Series CALOPHYLLAE Trelease

Quercus calophylla Cham. & Schlecht. in Linnaea 5: 79 (1830).

Guatemala: Depto. de Quiché: 6300 feet altitude at Nebaj, *Skutch nos. 1655 & 1656* represent an interesting extension of range for this common Mexican species.

Quercus chimaltenangensis Trelease in Jour. Wash. Acad. Sci. 23: 62 (1933).

This species is represented here by:

gemmata f. nov.

Differs from the type in having acute, fusiform buds much longer (2.5 x 6 mm.) and the lower surfaces of the leaves with a shorter tomentum.

A planta typica gemmis fusiformibus, acutis multo longioribus (2.5 x 6 mm.) atque foliis subtus tomentosulis differt.

Guatemala: Depto. de Quiché: 6300 feet altitude at Nebaj, *Skutch* no. 1654 (type in Ill.);—Depto. de Chimaltenango: 8300 feet altitude at Chichavac, *Skutch* no. 326 is a juvenile specimen and no. 683 is atypical in having narrower leaves (2.5-3.5 x 7-11 cm.), usually obtuse rather than attenuately acute as are both the species and type of this form.

Quercus pannosifolia sp. nov.

Twigs variable (1.5-3 mm. on the same specimen), from densely short stellate-tomentose becoming glabrate and dark reddish with prominent pale lenticels, graying the second year with lenticels protruding but less conspicuous. Buds shiny brown, glabrous, subovoid, acute, hardly 2 x 3 mm. Leaves deciduous?, moderate (4-6.5 x 10-15 cm. or, as in one specimen, about 3.5 x 9 cm.), narrowly obovate to rarely lanceolate, rounded to subcordate or rarely broadly cordate basally, the apex mucronately acute to subacute, dull olive-green above, glabrous save along the midrib near the base, densely detachably tomentose beneath, the surface minutely papillose; veins some 10 or 12 x 2 with occasional intermediates, irregularly branched and looping, all save the ultimate veinlets impressed above and prominent (even through the tomentum) beneath; petioles 1.5-2 x 10-15 mm., densely short dark tomentose to glabrate. Pistillate catkins 2- or 3-flowered on peduncles 1.5 x 8 or 10 mm. Fruit biennial, usually solitary; cups small (10-13 mm. in diameter) with brown tipped appressed scales canescent, the margin deeply inrolled or not at all; acorn ovoid or slender, downy about the apex, 8-11 x 15 mm., about one third included.

Ramuli 1.5-3 mm. crassi, dense stellato-tomentosuli vel glabrati, lenticellis pallidis prominentibus; gemmae nitido-brunneae, glabrae, acutae, vix 2 x 3 mm.; folia decidua (?), 4-6.5 x 10-15 cm., anguste obovata, apice mucronato-acuta, supra dilute olivacea, glabra, praeter costam basin versus, subtus dense caduco-tomentosum; nervis circa 10 vel 12 x 2 supra impressis subtusque prominentibus; petiolis 1.5-2 x 10-15 mm., dense obscureque tomentulis vel glabratis; amenta ♀ bi-vel triflora pedunculis 1.5 x 8 vel 10 mm.; fructus biennis, solitarius; cupulae 10-13 mm. in diametro, margine valde involuto vel recto; glans ovoidea vel gracilis, apice puberula, 8-11 x 15 mm., usque ad 1-3 cincta.

Guatemala: Depto. de Chimaltenango: 8300 feet altitude at Chichavac, *Skutch* no. 698 (type in Ill.).

This species may be distinguished from *Q. chimaltenangensis* by its long, dense stellate-tomentum and its small, usually slender acorn and delicate cup.

The Spider Genus *Lepthyphantes* in the United States¹

Helen M. Zorsch

INTRODUCTION

In this revision of the genus *Lepthyphantes*, comparative studies have been made of the spiders which have been placed in the related genera, *Troglohyphantes*, *Bathyphantes*, *Microneta* and *Stylophora*. The characters usually employed in determining generic relationships have been reviewed and in addition considerable attention has been given to the structure of the palpus, since this organ offers not only characters of specific value but many of generic significance.

ACKNOWLEDGEMENTS

The study has been carried on in the zoological laboratories at the University of Rochester under the supervision of Dr. S. C. Bishop to whom I am indebted for suggesting the problem and for helpful advice and criticism. The procedure for studying small spiders was perfected by the late Professor C. R. Crosby of Cornell University who not only placed at my disposal the entire Cornell University collection of spiders belonging to the groups studied and made many helpful suggestions, but permitted the use of his extensive library. The collection of types at the Museum of Comparative Zoology at Cambridge was made available for study through the courtesy of Mr. Nathan Banks and Miss Elizabeth B. Bryant to whom I express my sincere appreciation. To Helen Hayden Blauvelt at Cornell University my thanks are due for many hours of careful work in looking up obscure references and checking citations.

THE TYPE OF LEPHYPHANTES

Lepthyphantes Menge, Preuss. Spinnen, p. 131, 1866. Menge in effect designated the type by citing under the generic name "Pl. 24, tab. 53." This is the illustration of *Lepthyphantes musicola* Menge (equals *Linyphia minutus* Blackwall). Simon confirmed this (Ar. Fr. 5:265, 1884) by designating this species as type. The only other species that Menge included in *Lepthyphantes* was *crypticola* Walck., (equals *Linyphia nebulosa* Sund.). Simon (Hist. Nat. Ar. 1:705, 1894) gave as type of *Lepthyphantes*, *nebulosa* Sundevall. Petrunkevitch (Syst. Ar., p. 123, 1928) follows Simon (1894) and gives the type as *nebulosa*. This seems to be an error.

LEPHYPHANTES Menge

Preuss. Spinnen, p. 131, 1866.

Type: *Linyphia minuta* Blackwall.

Spiders of this genus are of moderate size, 2 to 4 mm. long. Cephalothorax usually yellowish suffused with dusky, moderately broad, strongly convergent anteriorly. Clypeus concave or straight below the eyes. Abdomen

¹ Contribution from the Department of Zoology, University of Rochester.

usually light with scattered silvery spots and dark transverse bands. Sternum and labium usually dark, endites lighter. Legs yellow, moderately long, metatarsus and tibia with several long, strong spines. Metatarsi and tibiae nearly equal, the metatarsus usually slightly shorter; in the type species it is a little longer. Anterior eyes viewed from above in profile, usually slightly recurved, rarely straight or slightly procurved, median smaller than the lateral separated by about the radius and from the lateral by about the diameter. Posterior eyes in a recurved line, median equal to or larger than the lateral, median separated by about the radius and from the lateral by nearly the diameter.

Femur of the male palpus slender, thicker and broader distally. Patella armed above with one or more very long, basally stout, apically slender or apically widened and rugose spines. Tibia short, about equal to the patella, usually simple but sometimes armed above with a strong spine or process.

The palpus of *Lepthyphantes* is a more specialized form of the *Linyphia* type described by Comstock.² The chief differences lie in the development of the following parts. The paracymbium is very large and strongly curved, the terminal part usually narrower, thinner and directed diagonally forward, or bent laterally across the face of the bulb; in certain species the terminal part is separated from the basal part by a distinct notch. The tegulum is widened, sometimes protuberant and often strongly ridged on the lateral side. The median apophysis is basally stout and apically produced as a single, long pointed process or into a broader part divided into several points. The base is flattened and more or less developed into two prongs at the point of attachment to the tegulum. The duct leaves the tegulum at the point of attachment of the median apophysis and passes between the prongs at the base of that structure. The duct then enters an elongate sclerite, the radix, which lies along the mesal edge of the cymbium and bears on its opposite (lateral) side, the embolus. Distally from the attachment of the embolus, on its lateral side, it bears a series of processes, the last of which is usually larger than the others and of characteristic form for the species. This piece is designated as the terminal apophysis. To this process the term "lamelle caractéristique" has been applied by Fage,³ Kulczynski, Jackson and others. In *Lepthyphantes* and its allies (*Microneta*, etc.) specialization has followed a line of development different from that taken by the *Linyphia* series and it seems impossible to homologize all the parts of the organ.

The epigynum is a protuberance of the ventral wall of the abdomen with an opening on its posterior side. The scape, which is a continuation of the middle part of the ventral wall of the epigynum, is usually constricted at base, then greatly widened and folded under itself and out again so that the narrow tip appears as a rounded tubercle at the end of the widened, visible part of the organ.

Lepthyphantes has as its nearest relative in North America the spiders of the genera *Microneta* and *Troglohyphantes*. From the former, *Lepthy-*

² Comstock, J. H.—The Palpi of Male Spiders, etc. in, *The Spider Book*, p. 112, 1912.

³ Fage, L.—*Arch. Zool. Expér.*, 71(2), 1931.

phantes differs in the following particulars: generally larger; the legs longer and with the metatarsus usually equal to or longer than the tibia, while in Microneta the metatarsi are shorter than the tibiae; the metatarsus usually has one spine in Lepthyphantes, none in Microneta; the abdomen in Lepthyphantes is usually grey marked with black bars and white spots, while Microneta is usually brown and uniformly colored; the eyes are generally larger in Lepthyphantes and tend to be in slightly recurved lines rather than straight or procurved as in Microneta; the paracymbium larger in Lepthyphantes; the terminal apophysis larger and more complicated; and the embolus not so prominent. The epigynum of the female in Lepthyphantes has a long process produced from the ventral wall which is lacking in Microneta. Lepthyphantes differs from Troglolyphantes as follows: the legs are longer in Lepthyphantes and the metatarsi equal to or longer than the tibia while in Troglolyphantes the metatarsi are shorter than the tibiae; Troglolyphantes possesses femoral spines; the eyes are large and close together in Lepthyphantes, while in Troglolyphantes they are smaller, farther apart, or lacking. Spiders of the genera Bathyphantes and Stylophora have been confused many times with Lepthyphantes but the true Bathyphantes and Stylophora have very distinct palpi and epigyne which separate them although the general appearance is much the same; the embolus is much longer and more sinuous in these genera and the epigynum is provided with a process from the dorsal wall which is lacking in Lepthyphantes.

Species which apparently belong in Lepthyphantes, described from females only:

Linyphia arctica Keyserling, Spinnen Amerikas 2:885, pl. 14, fig. 179. 1886.

Linyphia arcuata Keyserling, *ibid.*, 2:74, pl. 13, fig. 173. 1886.

Linyphia brevipes Keyserling, *ibid.*, 2:87, pl. 14, fig. 181. 1886.

Lepthyphantes lamprus Chamberlin, Can. Ent. 52: 195. 1920.

Species described as Lepthyphantes but belonging elsewhere:

Lepthyphantes alascensis Banks, Proc. Wash. Acad. Sci. 2:481, pl. 29, fig. 6. 1900.

Female only.

Lepthyphantes simplex Emerton, Can. Ent. 58:117, fig. 7. 1926 (=Microneta).

Lepthyphantes rubescens Emerton (Can. Ent. 58:117, fig. 8. 1926) from Massett, Queen Charlotte Islands, has not been available for study.

Lepthyphantes minuta (Blackwall)

Pl. 1, Figs. 1-6

Linyphia nebulosa Sundevall, (var. β) Svenska Spindl. part 1, p. 31 (of reprint) 1830; *Linyphia minuta* Blackwall, London Edinb. Phil. Mag. 3:191. 1833; Spid. Gt. Brit. 2:218, p. 1. 15, f. 144. 1864; Thorell, Syn. Europ. Spid. p. 55, 483. 1870; Horae Soc. Ent. Ross. 11:61. 1875; Cambridge, Spid. Dorset, p. 184. 1881; *Linyphia domestica* Wider, in Reuss Zool. Misc. Ar. p. 259, pl. 18, f. 1. 1834; Westring, Ar. Svec. p. 114 (in part). 1861; *Lepthyphantes muscicola* Menge, Preuss. Spinnen, 1:131, pl. 24, tab. 53. 1866; *Linyphia cingulipes* O. P. Cambridge, Linn. Soc. Trans. 27:428, pl. 55, f. 22, a-e (sec. Cambridge). 1871; *Bathyphantes minutus* Bertkau, Naturh. Ver. preuss. Rheinfl. Verh. 40:273. 1883; Strand, Arch. Math. Naturv. 21:20. 1899; *Lepthyphantes minutus* Simon, Ar. Fr. 5:271, ff. 20-22. 1884; Hist. Nat. Ar. 1:688, f. 771. 1894; Ar. Fr. 6(3):578, 730, ff. 865-866. 1929; Petrunkevitch, Catalogue, p. 245 (in part). 1911; Savory, Quekett Microsc. Clu. Jour. Ser. 2, 15:244, ff. 1-2. 1927; Biology of Spiders, pp. 86-87, 94, ff. 53-54, 57. 1928; Charitonov, Wiss. Mit.

Univ. Perm. Abt. 4 Naturw. 1:157. 1931; Mus. Zool. Acad. Sci. URSS. Ann. 32:75. 1932; *Lepthyphantes minutus* Chyzer and Kulczynski, Ar. Hung. 2:67. 1894; Comstock, The Spider Book, pp. 120, 380, ff. 117, 392. 1912; Kolosváry, Acta Biologica, n.s. 2(2):116. 1932.

Male.—Length, 4 mm. Cephalothorax orange suffused with dusky, darker at the margin and along the radiating lines; viewed from above moderately broad, the sides convergent toward the front; bluntly rounded across the front; anterior eyes in profile; viewed from the side, gently arched over the back to the cervical groove where there is a slight depression and then gently rounded over the head to the eyes. Clypeus nearly straight, gently slanting forward. Sternum and labium dark, nearly black over orange-brown ground color. Endites yellow-orange, slightly dusky posteriorly. Legs orange-yellow, dusky at the distal end and middle of each segment. Ratio of length of tibia to that of metatarsus as 113 to 120. Both tibia and metatarsus spined. Abdomen above dirty white with scattered silvery spots, marked on the anterior half with four dark, large, subquadrate blotches followed by three or four dark transverse bands; tip dark; the sides dark grey. Venter dark grey, lighter across the middle, on either side a narrow curved light line separating the grey of the venter from that of the sides.

Posterior eyes in a slightly recurved line, median slightly larger than the lateral, separated by a little more than the radius and a little farther from the lateral. Anterior eyes in a slightly procurved line, median smaller than the lateral, separated by about the radius and from the lateral by the diameter.

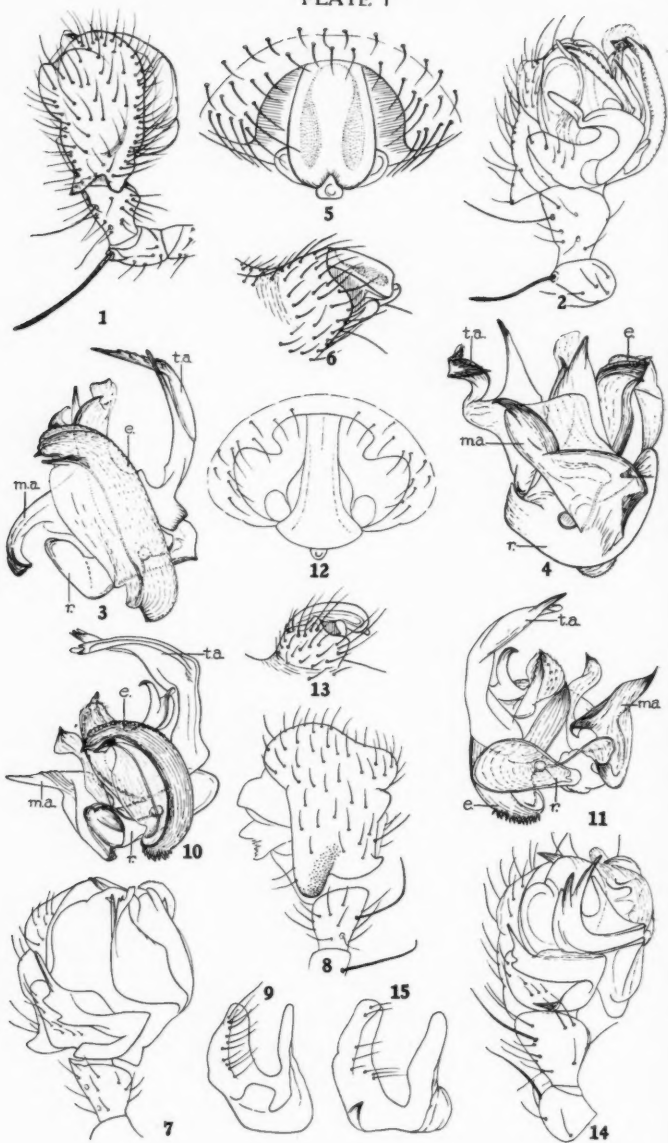
Femur of palpus moderately stout, nearly cylindrical, slightly convex laterally. Patella short, the sides slightly convex, armed above near the tip with a long black spine rugose at the tip. Ratio of length of femur to that of patella as 45 to 13. Tibia short, narrow at base and with the sides strongly convex and the dorsal edge unspecialized, armed above toward the tip with a long, slender curved spine. The paracymbium is strongly curved, the base wide and armed with a group of short hairs, the angle hollowed out and the tip flattened and bent sharply forward. The median apophysis is wide at the base, constricted at the middle of its length and tapers to a single sharp tip. The radix is broad and roughly boat-shaped. The embolus is broad and flat, somewhat crescentic and roughly distally. The terminal apophysis is long and slender and provided with two branches, one slender, straight and tapering, the other wider, bent at a broad angle and having its tip serrated.

Female.—Length, 4 mm. Generally similar to the male but with the cephalothorax slightly larger and darker. Abdomen larger than in male, generally lighter but with the same markings.

Posterior and anterior eyes are same relative size, shape, and position as in male.

The epigynum is an oval, transverse, protuberant plate. The fovea is divided by a broad process slightly constricted at the base and broad and flat distally, shallowly grooved on the surface by two furrows. This process is folded upon itself, then again produced backward so that the tip is exposed as a small rounded projection beyond the widened part of the first fold. The

PLATE 1



lateral lobes of the epigynum are narrow and sharply curved toward the process.

Type locality.—Scania, Sweden (an old southern province now in the läns of Malmöhus and Christianstad).

ENGLAND: Warwickshire, 1 ♂, 1 ♀. FRANCE: 1 ♂, 2 ♀.

Lepthyphantes leprosa (Ohlert)

Pl. I, Figs. 7-13

Linyphia domestica Westring (not Wider), Ar. Svec. p. 114 (in part). 1861; *Linyphia leprosa* Ohlert, Arachn. Studien, p. 12. 1865; Ohlert, Aran. Prov. Preuss. p. 47. 1867; Thorell, Horae Soc. Ent. Ross. 11:61. 1875; Cambridge, Spid. Dorset, p. 181. 1881; *Linyphia confusa* O.P. Cambridge, Linn. Soc. Lond. Trans. 27:462, 427, pl. 55, f. 21, a-g. 1871; *Bathypantes minuta* Emerton, Conn. Acad. Sci. Trans. 6:68, pl. 21, f. 4. 1882; Banks, Phila. Acad. Nat. Sci. Proc. 1892, p. 44; *Lepthyphantes leprosus* Simon, Ar. Fr. 5(2):279, ff. 31-32. 1884; Ar. Fr. 6(3):580, 730, ff. 896-870. 1929; Kulczynski, Denks. Acad. Wiss. Krakau 11:8. 1885; Acad. Sci. URSS. Ann. Mus. Zool. 27:33. 1926; Chyzer and Kulczynski, Ar. Hun. 2:67, pl. 2, f. 32. 1894; de Lessert, Cat. Ar. Suisse, p. 245. 1910; Bösenberg, Spinnen Deutschl. p. 74, pl. 4, f. 78. 1903; Spassky, Don. Polytechn. Inst. Ann. 3:88. 1914; Savory, Quekett Microsc. Club Jour., Ser. 2, 15:244, ff. 1-2. 1927; Biology of Spiders, p. 216. 1928; Charitonov, Sci. Soc. Biol. Inst. Univ. Perm Proc. 6:4. 1928; Mus. Zool. Acad. Sci. URSS. Ann. 32:74. 1932; Peresleschina, Bul. Stat. Biol. Soc. Amis Sci. Nat. Anthrop. Ethnogr. Bolshevo, 2:19. 1928; Denis, Soc. Ent. France Ann. 99:302. 1930; Bristowe, Zool. Soc. London Proc. 1931, 3:955; Fage, Arch. Zool. Expér. 71(2):106, 181, 235, 256, 258-259, 262, 265-266, 272. 1931; Kolosváry, Acta Biologica n. s. 2(2):116. 1932; *Bathypantes leprosus* Bertkau, Naturh. Ver. preuss. Rheinh. Verh. 40:273. 1883; *Linyphia galbea* Keyserling, Spinnen Amerikas, Theridiidae, 2:83, pl. 14, f. 178. 1886; Banks, U. S. Nat. Mus. Bul. 72:33. 1910; Phila. Acad. Nat. Sci. Proc. 1913, p. 179, ff. 28, 31; *Linyphia* (*Bathypantes*) *minuta* Emerton, Common Spiders, p. 144, ff. 342-344. 1902; *Bathypantes galbea* Banks, Phila. Acad. Nat. Sci. Proc. 1911, p. 448; *Lepthyphantes minutus* Petrunkevitch, (in part) Catalogue, p. 245. 1911; *Lepthyphantes leprosus* Reimoser, Katalog, p. 90. 1919; Charitonov, Mus. Zool. Acad. Sci. URSS. Ann. 26: 108. 1925; *Lepthyphantes minutus* Emerton, Nantucket Maria Mitchell Ass. Publ. 3(2):165. 1930.

Male.—Length, 3 mm. Cephaloprothorax yellow-brown suffused with dusky, slightly darker at the margin and with dusky radiating lines; viewed from above moderately broad, evenly rounded at the sides and convergent

PLATE I

Lepthyphantes minuta

FIGURES

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| 1. ♂, right palpus, dorsolateral view. | 4. ♂, embolic subdivision of right palpus, inside view. |
| 2. ♂, right palpus, lateral view. | 5. ♀, epigynum, ventral view. |
| 3. ♂, embolic subdivision of right palpus, outside view. | 6. ♀, epigynum, lateral view. |

Lepthyphantes leprosa

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| 7. ♂, right palpus, ventrolateral view. | 11. ♂, embolic subdivision of right palpus, inside view. |
| 8. ♂, right palpus, dorsomesal view. | 12. ♀, epigynum, ventral view. |
| 9. ♂, paracymbium. | 13. ♀, epigynum, lateral view. |
| 10. ♂, embolic subdivision of right palpus, outside view. | |

Lepthyphantes cracens

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| 14. ♂, right palpus, ventrolateral view. | 15. ♂, paracymbium. |
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toward the front, the cephalic groove well marked, the anterior eyes in profile; viewed from the side, gently arched over the back to the cervical groove where there is a very slight depression and then gently arched over the head to the eyes. Clypeus nearly straight, gently slanting forward. Sternum dark, black over orange-brown ground color. Endites yellow-orange, slightly dusky basally, labium lighter. Legs orange-yellow, with the long segments dusky at their end and in a broad band at the middle of each part. Length of tibia and that of metatarsus about equal. Both tibia and metatarsus spined. Abdomen with ground color above yellowish grey and with scattered silvery spots, the basal third with a dark shield-shaped spot followed by four or five dark, transverse bands, tip dark; the sides dark with a light stripe. Venter dark grey sometimes with a lighter transverse band.

Posterior eyes in a slightly recurved line, equal, median separated by the radius and from the lateral by a little more. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by less than the radius and from the lateral by a little less than the diameter.

Femur of palpus rather slender, thicker and broader distally. Patella short, strongly convex above. Ratio of length of femur to that of patella as 40 to 15. Patella armed above with a very long, basally stout, apically slender spine. Tibia simple, about as wide as long, swollen ventrally, and armed above with a long slender curved spine. The cymbium, on the lateral side at base, produced into a short horn, and mesally into a broad, compressed lobe, granulate on the inner side. The paracymbium is very deeply grooved with a deep narrow notch in both flanges, a large, thin quadrate lobe on the outer flange proximad of the notch, the inner surface at the base clothed with a cluster of stiff hairs, the tip much narrower and bent in toward the bulb with two triangular teeth at the base of the narrower part on the outer margin. The median apophysis is narrow with parallel sides, slightly curved and with a stout tooth which is black at tip. Radix is short and wide, not much constricted beyond the tooth, the end incurved and appearing gently rounded. The embolus is curved across the face of the bulb, the concave side filled by a broad thin expansion, grooved at base, the lower flange armed with a cluster of blunt spines at the base and toward the tip minutely serrate; the tip is incurved, obliquely pointed and the embolus opens through a black tubercle some distance from the end. At the tip of the radix on the inner side is attached the terminal apophysis consisting of several elements only one of which, the terminal one, is conspicuous in the untreated palpus. This is very long, slender at base, concave laterally, greatly widened at the middle and has a very deeply cleft tip, the mesal part ending in three teeth and a flattened plate and the slender lateral part ending in one or two small black teeth and a longer oblique tooth. In a cleared specimen the process nearest the embolus is thin and trough-shaped, the surface minutely reticulate, the end truncate; the middle process is strongly chitinated and has the form of a band curved in a semi-circle, with a long, curved, horn-like process on one corner and a shorter one on the other.

Female.—Length, 3 mm. Similar to male in form and color, but the abdomen larger and lighter.

Posterior and anterior eyes are same relative size, shape and position as in male.

The epigynum is an oval, transverse, protuberant plate. The scape is wide at base, slightly narrowing toward the tip and then abruptly widened distally. The scape is turned forward, then folded back on itself and ends in three lobes, the middle one of which is exposed at the tip of the first fold and the lateral ones on each side. The sides of the epigynum are distinctly angulate and converge slightly behind.

Type locality.—Gothenburg, Sweden.

MICHIGAN: Albion, June 22, 1932 (Chickering) 2♀. NEW HAMPSHIRE: Hollis, Aug., (Fox) 2♀. NEW YORK: Keuka Lake, Sept.-Oct. 1903 (Crosby) 3♂ 7♀; Keuka Park, Oct. 29, 1918, 3♀; Ithaca, 2♀; Oct. 16, 1915, 1♂ 2♀; Oct., 1♀; Aug., 1903, 1♀; July 23, 1902, 2♀; Bluff Point, Fall 1904, (Heck) 7♂ 5♀; Rochester, Mar. 19, 1932, (Bates) 1♀; July 27, 1932, (Bates) 1♂; Aug. 23, 1932, (Bates) 2♀; Sept. 18, 1932, (Bates) 1♂; Sept. 20, 1932, (Bates) 1♂ 1♀; Sept. 24, 1932 (Bates) 1♂; Oct. 10, 1932, (Bates) 1♂; Oct. 12, 1932, (Bates) 1♂; Oct. 18, 1932, (Bates) 1♂; Oct. 22, 1932 (Bates) 1♀; May 4, 1933 (Bates) 1♂; Chilson Lake, Essex Co., Sept. 1904, 1♂; Perry City, Sept. 8, 1903, 1♂ 4♀; Akron, July 8, 1919, 3♂ 5♀; Boonville, July 18, 1931, (Karleskind) 2 im. ♂ 1♀; Geneva, Nov. 14, 1914, 2♀; Newcomb, Sept. 20, 1924, 1♂ 2♀; Mt. Whiteface, Aug. 25, 1921, 1♀. OHIO: Lancaster, 1873 (Holden) 2♀. RHODE ISLAND: Kingston, Aug. 1907, 1♂. ENGLAND: Warwickshire, 2♂; Yorkshire, 4♀. FRANCE: 1♂ 1♀. NOVA SCOTIA: Granville Ferry, 1♀.

***Lepthyphantes cracens* sp. nov.**

Pl. 1, Figs. 14-15.

Male.—Length, 2 mm. Cephalothorax greyish brown, the radiating lines and the angular area on the back of the head darker grey; viewed from above rather broad, widest at the second coxae, rapidly narrowed forward without a constriction at the cervical groove; anterior eyes in profile; viewed from the side gently ascending behind to the cervical groove where there is a slight depression, then evenly and gently rounded over the head to the eyes. Clypeus nearly straight, slanting forward. Sternum and labium very dark gray over orange. Endites brownish orange. Chelicerae grayish brown, rather long, nearly straight slightly divaricate at the tip. Legs orange yellow; palpi grayish. Ratio of length of tibia to that of metatarsus as 9 to 8. Abdomen light above with a black large triangular spot at the base, and above followed by three or four dark transverse bars, and above this a light spot on either side of the basal dark mark continued along the sides as a narrow light line, and an abbreviated black lateral stripe; venter black.

Posterior eyes in a very slightly recurved line, the median separated by a little less than the diameter and from the lateral by a little more than the radius. Anterior eyes in a straight line, the median smaller than the lateral, separated by three fourths the diameter and from the lateral by the diameter.

Femur of palpus rather short and stout, distinctly thickened distally. Patella very short, armed dorsally near the tip with a long spine. Ratio of length of femur to that of patella as 35 to 10. Tibia short, the distal dorsal

margin smooth and straight, armed dorsolaterally with a long spine. Cymbium smoothly rounded over the back with only a low rounded protuberance at the base on the lateral side. Paracymbium rather long but narrow and very strongly curved with the tip narrow and turned inward towards the bulb as in *zebra*; the basal part is armed with a group of five hairs and two more at the anterior tip of the base; the posterior margin is armed with an acute black tooth; the notch is deep, narrow and oblique; the terminal part is not cut off from the outer arm by a distinct notch as in *zebra*. Median apophysis is armed with a single long, acute tooth. Radix is constricted near the base, the mesal edge smoothly rounded, the tip slightly produced, rounded, with the lateral angle nearly square. Embolus is thin and delicate, narrow at the base, expanded in the middle; next to it is a thin, hyaline process armed with four or five erect teeth which show through the edge of the embolus. Terminal apophysis is narrow at the base, bent sharply towards the edge of the cymbium around the angle of the paracymbium; it then curves towards the apex of the bulb and ends in two long, acute teeth, the lateral one the shorter.

Holotype, male.—Mt. Whiteface, New York, Aug. 25, 1921 (C. R. Crosby).

NEW YORK: Mt. Marcy, Aug. 27, 1930 (C. R. Crosby) 1 ♂.

Lepthyphantes nebulosa (Sundevall)

Pl. 2, Figs. 16-23.

Linyphia nebulosa Sundevall, Svenska Spindl. part 1, p. 31 (of reprint). 1830; Thorell, Syn. Europ. Spid. pp. 54-55. 1870; Horae Soc. Ent. Ross. 11:61. 1875; Kroneberg, Ar. in Fedtschenko's Reise Turkestan, p. 8. 1875; L. Koch, Sven. Vet.-Akad. Handl. 16(5):8. 1879; Cambridge, Spid. Dorset, p. 512. 1881; Keyserling, Spinnen Amerikas, Theridiidae, 2:75, pl. 13, f. 174, 1886; *Linyphia* (*Bathyphantes*) *nebulosa* Emerton, Common Spiders, p. 143, ff. 336-341. 1902; *Linyphia furcula* C. Koch, Übers. Ar. Syst. 1:10. 1837; Die Ar. 12:116, f. 1040. 1845; *Linyphia circumflexa* C. Koch, Die Ar. 12:128, f. 1050. 1845; Ohlert, Aran. Prov. Preuss. p. 45. 1867; *Linyphia vivax* Blackwall, Linn. Soc. London Trans. 18:657. 1841; Spid. Gt. Brit. 2:221, pl. 16, f. 146. 1864; *Linyphia autumnalis* Hentz, Bost. Soc. Nat. Hist. Jour. 6:30, pl. 4, f. 9. 1850; Burgess reprint, p. 135, pl. 15, f. 9, pl. 18, ff. 71, 97. 1875; *Linyphia crypticola* Westring (not Walckenaer) Förtechn. Sv. Spindl. p. 37. 1851; Ar. Svec. p. 113. 1861; *Lepthyphantes crypticola* Menge, Preuss. Spinnen, 1:133, pl. 25, tab. 54. 1866; *Bathyphantes nebulosa* Emerton, Conn. Acad. Sci. Trans. 6:69, pl. 22, f. 1. 1882; Banks, Phila. Acad. Nat. Sci. Proc. 1892. p. 44; Knobel, Spid. of Northern States, p. 42, f. 28. 1901; Bryant, Bost. Soc. Nat. Hist. Occ. Papers, 7(9):42. 1908; *Bathyphantes nebulosus* Bertkau, Naturh. Ver. preuss. Rheinl. Verh. 40:274. 1883; Strand, Arch. Math. Naturv. 21:20. 1899; Arch. Naturg. Abt. A. 92(7):88. 1926; *Lepthyphantes nebulosus* Simon, Ar. Fr. 5:273, ff. 23-25. 1884; Ar. Fr. 6:574, 478, 730, ff. 861-862. 1929; Spassky, Zool. Anz. 40:182. 1912; Spassky and Levroff, Siberian Inst. Ag. and Forest. Omsk Trans. 10:6. 1928; Fedotow, Mus. Zool. Acad. Sci. St. Petersburg. Ann. 20:449 for 1915. 1916; Grese, Bul. Soc. Ent. Moscow 1:107. 1915; Emerton, Ent. Soc. Nova Scotia, Proc. 3:96, for 1917. 1918; Royal Can. Inst. Trans. 12:319. 1919; Gassman, Zeit. Morph. Ökol. Tiere, 5:98. 18 text figs. 1926; Savory, Quekett Microsc. Club Jour., Ser. 2, 15:244, ff. 1-2. 1927; Pereleschina, Bull. Stat. Biol. Soc. Amis Sci. Nat. Anthropol. Ethnol. Bolshevo 2:19. 1928; Fage, Arch. Zool. Expér. 71(2):106. 1931; Worley, Univ. Wash. Publ. Biol. 1(1):30. 1932; Charitonov, Mus. Zool. Acad. Sci. URSS. Ann. 32:75. 1932; *Lepthyphantes nebulosa* Banks, U. S. Nat. Mus. Bul. 72:34. 1910; Phila. Acad. Nat. Sci. Proc. p. 76, 1916; U. S. Nat. Mus. Proc. 51:69, 1916; Barrows, Ohio Jour. Sci. 18(8):306. 1918; *Lepthyphantes nebulosus*

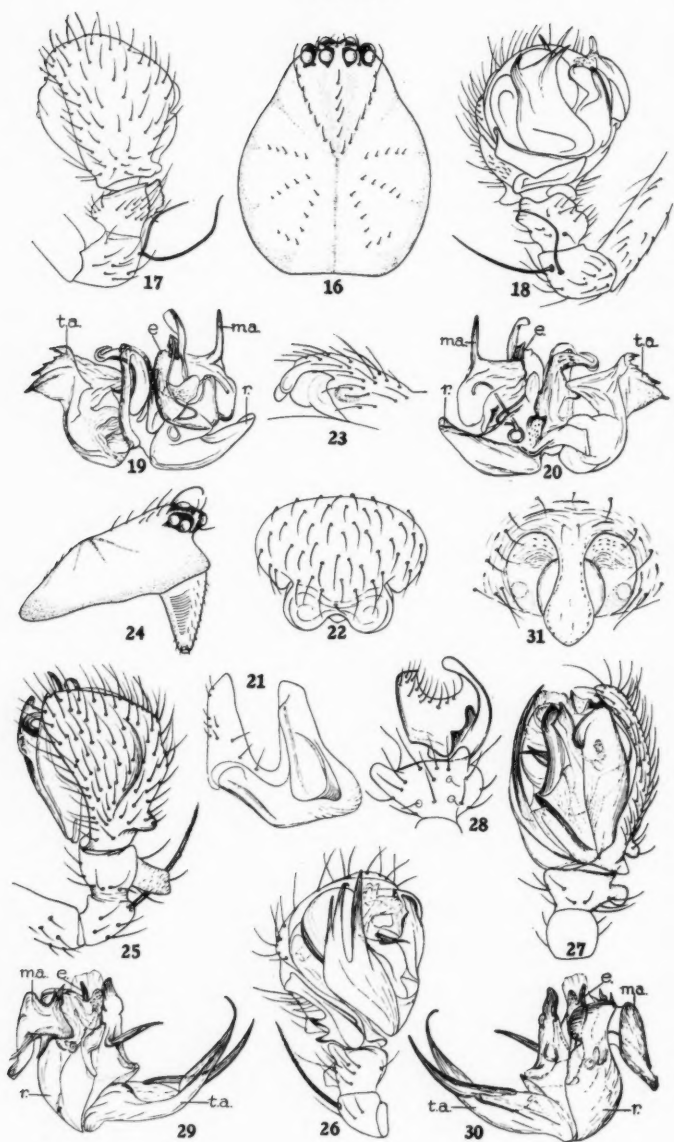
Simon, Hist. Nat. Ar. 1:705. 1894; Chyzer and Kulczynski, Ar. Hung. 2:67. 1894; Petrunkevitch, Catalogue, p. 245. 1911; Conn. Acad. Sci. Trans. 29:123. 1928; Hull, Nat. Hist. Soc. Northumberland, etc., Trans. n.s. 3:575. 1911; Comstock, The Spider Book, p. 380, ff. 390-391. 1912; Worley and Pickwell, Neb. Univ. Studies, 27(1-4):34. 1931; Kolosváry, Acta Biologica, n.s. 2(2):116. 1932.

Male.—Length, 3.5-4 mm. Cephalothorax dull orange suffused with dusky, darker at the margin, and with a dark longitudinal stripe which extends along the mid-line and from the cervical groove separates into two lines which extend to the posterior median eyes; head armed above with three lines of curved hairs extending forward from the junction of the cervical grooves, the center line to a point just behind the posterior eyes and the lateral lines to the posterior lateral eyes; viewed from above moderately broad, the sides convergent toward the front; the anterior eyes in profile; viewed from the side, gently arched over the back to the cervical groove where there is a depression and then arched gently over the head to the eyes. Clypeus straight, gently slanting forward. Sternum and labium dusky, over orange ground color. Endites orange-yellow, dusky distally. Legs dark yellow. Ratio of length of tibia to that of metatarsus as 1.1. Both tibia and metatarsus spined. Abdomen with the ground color above varying from yellowish white to dull greyish white and marked with scattered silvery spots, and with a series of 5 or 6 transverse broken dark bars; tip dark; the sides with a light and two broken dark stripes. Venter with scattered silvery spots and a broad longitudinal dusky band usually surrounded by lighter and often marked with a median longitudinal light stripe.

Posterior eyes in a slightly recurved line, equal, the median separated by nearly the diameter and from the lateral by a little more than the radius. Anterior eyes in a slightly recurved line, median smaller than the lateral, separated by less than the radius and from the lateral by a little more than the radius.

Femur of palpus rather slender, somewhat thicker and broader distally. Patella short and convex above. Ratio of length of femur to that of patella as 26 to 12. Patella armed with two long spines, the mesal one the larger, both apically slender and stout at base. Tibia short and swollen ventrally, viewed from above the mesal side strongly convex, the lateral side protuberant. Tibia armed dorsally with a longitudinal, quadrate ridge the upper edge of which is irregularly dentate with the sides striate. Tibia very deeply excavated on the mesal side of the ridge. The cymbium is rounded over the back and near the lateral side is provided with a deep groove, the inner margin of which at base is armed with a thin ridge forming a blunt-pointed tooth. The basal part of the paracymbium is large with a row of stiff hairs on the inner and posterior edges. What might be mistaken for the base in the untreated specimen is really a flat branch of the basal part directed toward the cymbium. The paracymbium is bent to form a deep notch with parallel sides, greatly widened at the bend, crossed by a deep groove in line with the notch. This groove is bounded posteriorly by a ridge in part formed by the flattened basal part and bounded anteriorly by a thickened ridge which becomes very thin apically. The tip of the paracymbium is thin and broad, the distal margin obliquely rounded.

PLATE 2



The median apophysis has the tooth long, gradually tapering toward the tip and distinctly curved ventrally. The radix appears as a large, smooth plate occupying the basal part of the bulb between the mesal side of the cymbium and the paracymbium; the proximal end is rounded; it is deeply cleft at the base of the embolus, the mesal branch rather thick, smooth, rounded at tip, the lateral branch thinner, incurved, expanded and constricted before the end which is small and rounded. The duct enters the radix on the side toward the embolus and is expanded to form a clear circular vesicle, and then emerges to enter the base of the embolus. The embolus is curved, concave toward the cymbium, basally thin and folded so as to form a deep groove; the lower flanges are smooth, the upper surface minutely aciculate, the margin minutely serrate, the tip blackish, narrower, bearing the opening of the duct. Between the embolus and the lateral edge of the cymbium there are four processes to be seen, all of which are attached to the inner surface of the proximal end of the radix. The first process lies close under the edge of the embolus, the exposed part is distally pointed and basally rounded; the second process is thin, broad at base, strongly curved laterally and ends in a slender, sharply recurved tail-like crook; the third process partly overlies the second and when viewed from below appears as the edge of a black, sinuous plate a little thicker distally; in side view seen to be broad in the middle terminating in a rather long, slightly curved pointed tooth; the fourth, or terminal apophysis, is a broad, thin, wrinkled convex plate armed laterally with a rather long, bluntly-pointed projection and apically with three acute, oblique teeth.

Female.—Length, 4 mm. Carapace similar to the male in form and markings. Abdomen larger than in the male, generally lighter but with the same markings. Venter same as in male.

Posterior and anterior eyes larger proportionately, but same shape and position as in male.

The epigynum is astrongly convex, transverse plate produced behind into two broadly rounded lobes differing in texture from the atrium and prob-

PLATE 2

Lepthyphantes nebulosa

FIGURES

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| 16. ♂, cephalothorax, dorsal view. | 20. ♂, embolic subdivision of right palpus, inside view. |
| 17. ♂, right palpus, dorsomesal view. | 21. ♂, paracymbium. |
| 18. ♂, right palpus, lateral view. | 22. ♀, epigynum, ventral view. |
| 19. ♂, embolic subdivision of right palpus, outside view. | 23. ♀, epigynum, lateral view. |

Lepthyphantes alpina

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| 24. ♂, cephalothorax, lateral view. | 29. ♂, embolic subdivision of right palpus, inside view. |
| 25. ♂, right palpus, dorsomesal view. | 30. ♂, embolic subdivision of right palpus, outside view. |
| 26. ♂, right palpus, ventrolateral view. | 31. ♀, epigynum, ventral view. |
| 27. ♂, right palpus, mesal view. | |
| 28. ♂, tibia and paracymbium. | |

ably representing the scape which is developed as a single tongue-like structure in some other species. The scape above the rounded lobes, invisible in the untreated specimens, narrows abruptly and continues forward a short distance; it then widens gradually and is folded back so that its greatly expanded and spectacle-shaped tip lies beneath the two broad lobes visible at the surface.

Type locality: Scania, Sweden (An old southern province now in the läns of Malmöhus and Christianstad).

COLORADO: Bear Creek, Morrison, Aug. 1906 (Oslav.) 1♂. LOUISIANA: 1♂. MASSACHUSETTS: Fitchburg, July, 1888 (Fox) 1♀. NEW HAMPSHIRE: Hollis, Aug. (Fox) 1♂. NEW YORK: Crosby, Oct. 1918 (Crosby) 1♂; Geneva, Nov. 14, 1914, 1♂ 1♀; Ithaca, Apr. 1♂ 1♀; Oct. 13, 1918 (Crosby) 1♂ 1♀; Oct. 15, 1905, 3♂ 1♀; Oct. 13, 1922, 1♀; Oct. (Crosby) 1♀; Perry City, Sept. 8, 1903, 2♀; Long Island (Banks) 1♀; Bluff Point, Sept., 1911, 1♀; Rochester, Oct. 27, 1931 (Bates) 2♂ 2♀; Nov. 19, 1931 (Bates) 1♀; Nov. 28, 1931 (Bates) 1♀; Dec. 3, 1931 (Bates) 1♂ 1♀; Dec. 5, 1931 (Bates) 1♀; Dec. 6, 1931 (Bates) 1♀; Dec. 21, 1931 (Bates) 2♀; Jan. 14, 1932 (Bates) 1♂; Jan. 20, 1932 (Bates) 1♀; Jan. 22, 1932 (Bates) 1♀; Sept., 1932 (Bates) 1♂ 1♀; Dec. 3, 1932 (Lewis) 1♀; Nov. 10, 1932 (Bates) 1♀; Old Forge, Aug. 8, 1905, 1♂ 5♀; Boonville, July 18, 1931 (Karleskind) 2♀. UTAH: Salt Lake City, Sept. 1930 (Gertsch) 4♀. ENGLAND: Warwickshire, 1♂ 1♀. FRANCE: 1♂ 1♀. NOVA SCOTIA: Granville Ferry, 1♀. RUSSIA: Don, 1♂ 1♀.

Lepthyphantes alpina (Emerton)

Pl. 2, Figs. 24-31

Bathyphantes alpina Emerton, Conn. Acad. Sci. Trans. 6:70, pl. 22, f. 4, 1882; Appalachia, 8(2):155. 1914; *Linyphia alpina* Marx, Catalogue, p. 527. 1890; *Bathyphantes zebra* Banks, Phila. Acad. Sci. Proc. 1892, p. 44; *Lepthyphantes alpina* Emerton, Royal Can. Inst. Trans. 12:318. 1919.

Male.—Length, 2-2.2 mm. Cephalothorax yellow suffused with dusky, darker at the margin; viewed from above moderately broad, evenly rounded on the sides to the cervical groove; strongly convergent toward the front; the anterior eyes in profile; cephalothorax viewed from the side, rather steeply ascending behind to the cervical groove where there is a slight depression and then gently arched over the head to the eyes; a large black spine arises behind the posterior median eyes and is directed forward, the tip curved sharply downward. Clypeus straight, gently slanting. Sternum and labium dark, nearly black over yellow ground color. Endites yellow, strongly suffused with dusky. Legs light yellow. Ratio of length of tibia to that of metatarsus as 50-49. Both tibia and metatarsus are spined. Abdomen light with scattered silvery spots and a basal lancolate dark stripe followed by four or five pairs of dark spots or transverse bands; tip dark, the sides with a dark and a light stripe. Venter dark gray.

Posterior eyes in a slightly recurved line, equal, median separated by a little less than the diameter and from the lateral by the radius. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated

by $\frac{2}{3}$ the diameter and from the lateral by a little more than the diameter.

Femur of palpus rather slender, thicker and broader distally. Patella short, tapering distally. Ratio of length of femur to that of patella as 30-10. Patella short, armed dorsally with a very long, black spine, stout at the base, pointed at tip and markedly rugose on the distal half. Tibia short, viewed from above concave mesally, convex laterally, the dorso-lateral angle produced into a large blunt-pointed tooth, the dorso-mesal angle produced into a large round process squarely truncate at tip and directed dorsally. Cymbium narrow at base, rounded over the back and with a rounded projection near the base on the lateral side, which is greatly excavated to receive the paracymbium. Paracymbium broad at base, where it is armed with a large group of short stiff hairs, deeply hollowed out and bent to form a deep notch; posterior margin with two large, blunt teeth separated by a deep rounded notch, the mesal branch of paracymbium produced at tip into a broad, flat, round-pointed process. The median apophysis exposed at tip of the bulb as a small black triangular piece, the distal and ventral angles produced into two long black teeth. Radix long and leaf-like, rounded and thickened at base, pointed at tip, convex externally and lying next to the mesal edge of the cymbium. The embolus is rather small, narrow at base, thin and widened distally, the tip produced into a short, flat, bluntly rounded lobe and a sharp pointed black tooth through which the duct opens. The embolus arises near the base of the radix and is visible at the extreme tip of the unexpanded bulb. The post-embolic division consists of four distinct sclerites, a narrow, thin basal piece at the tip of which is attached a flat, sinuous and pointed sclerite which bears on its lateral side a long, strong and sharply pointed tooth; from the lateral side of the basal piece there arises two very long, tapering sharp-pointed processes, the outer process incurved at tip and provided with a slender sharp-pointed tooth on the lateral side near tip. These two distal processes in the unexpanded bulb extend along the lateral face and represent the modified "lamelle."

Female.—Length, 2 mm. Carapace slightly darker than in the male, smaller but the same shape. The eyes in profile. Clypeus same as in the male. Sternum, labium and endites similar. Abdomen larger than male but with the same markings and color. Venter generally grayish.

Posterior and anterior eyes larger than in the male and closer together, but otherwise similar.

The epigynum is a transverse plate broadly rounded in front, the sides straight and nearly parallel and with the posterior margin forming a straight line. The spoon-shaped scape arises at the anterior margin and is strongly protuberant; it is folded forward, then backward, the tip split to form two flattened and rounded branches which are visible from the ventral side, one on either side of the scape just in front of the first fold.

Type locality: Mt. Washington, New Hampshire. Type studied at the Museum of Comparative Zoology.

COLORADO: Pingree Park, Aug. 19, 1924 (Crosby) 1♀. MAINE: Bayville, 1900 (J. H. Emerton) 1♀; Orono, 1924 (Blake) 1♀. NEW HAMPSHIRE: Mt. Washington Half-way House, July 5, 5, 1935 (Crosby) 1♀. NEW YORK: Chapel Pond; Essex Co., Aug. 24, 1930, 4♂; June 27, 1925 (Clausen) 1♂ 1♀; Oct. 20, 1934 (C.R.C.) 4♀; Newcomb, July 1918, 2♀; Mt. Whiteface, Aug. 25, 1921, 1♀; Aug. 22, 1916, 4♂; Sept. 13, 1931 (Hammer) 1♀; Mt. Marcy, Aug. 27, 1930 (Crosby) 2♀; Amper-sand Brook, Franklin Co., July 19, 1931 (Crosby and Hammer) 1♀; Wawbeek, July 19, 1931 (Crosby and Hammer), 1♂; Oct. 23, 1934 (Crosby) 1♀; Slide Mt., Ulster Co., Aug. 9, 1923, 2♀; Artist Brook, Essex Co., June 28, 1923, 1♂ 1♀; June 11, 1923 (Crosby) 3♂; Avalanche Lake, July 24, 1925, 2♀; Charley Lake, Hamilton Co., Apr. 27, 1923, 2♀. VERMONT: Mt. Mansfield, July 5, 1935, (Crosby) 1♀. CANADA: Banff, Alberta, Sulphur Mt., Aug. 2, 1927, 1♀; Quebec, Bagotville, July 26, 1934 (C & Z) 2♀.

The female type specimen does not resemble the female usually found with *Lepthyphantes alpina* Emerton but more closely resembles *Lepthyphantes subalpina* Emerton.

Lepthyphantes subalpina (Emerton)

Pl. 3, Figs. 32-35

Bathyphantes subalpina Emerton, Conn. Acad. Sci. Trans. 6:70, pl. 22, f. 3. 1882; Can. Ent. 50:129. 1918; Banks, Phila. Acad. Sci. Proc. 1892, p. 44; U. S. Nat. Mus. Bul. 72:35. 1910; *Linyphia subalpina* Marx, Catalogue, p. 528. 1890; *Bathyphantes subalpinus* Gibson, Ent. Soc. Ont. Rept. 47:170. 1917; *Lepthyphantes subalpina* Emerton, Royal Can. Inst. Trans. 12:319. 1919.

Male.—Length, 2.6 mm. Carapace orange-yellow suffused with dusky, darker at the margin; viewed from above moderately broad, evenly rounded on the sides to the cervical groove, then strongly convergent toward the front; anterior eyes in profile; viewed from the side somewhat depressed, gently arched over the back to the cervical groove where there is a slight depression and then gently arched over the head to the eyes; a median row of five or six dark hairs over the head and between the posterior median eyes. Clypeus nearly straight, gently slanting forward. Sternum and labium dark brown, nearly black over orange ground color. Endites orange-yellow, suffused with dusky. Legs orange-yellow. Ratio of length of tibia to that of metatarsus as 51 to 50. Both tibia and metatarsus spined. Abdomen dark with scattered silvery spots and marked with interrupted transverse light bands and a pair of light spots one at each side at base; tip dark; the sides with a dark and a light stripe. Venter dark grey.

Posterior eyes in a very slightly recurved line, equal, separated by a little less than the diameter and from the lateral by the radius. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by the radius and from the lateral by about the diameter.

Femur of palpus moderately long and somewhat thickened distally. Patella short, broadly rounded distally, armed above with a very long spine, stout at base, and more slender at the tip where it is slightly rugose. Ratio of length of femur to that of patella as 20 to 7. Tibia short, widened distally, with the distal dorsal edge unspecialized. The paracymbium is very broad and deeply hollowed out and protuberant ventrally; the distal margin is developed anteriorly with a long, flat curved process; the distal margin is produced post-

eriorly with a large curved process broad at base and narrowed at the tip. The basal half of the anterior margin produced into a stout ridge bearing about a dozen, long, strong, curved hairs just back of the margin, the posterior margin with a broad emargination. The cymbium viewed from above is narrow at base and provided with a small blunt-pointed process directed dorsally. The tegulum is exposed on the lateral side of the bulb as a broad, smooth, convex plate, widened distally and produced dorsally into a broad bluntly pointed process. The median apophysis is widened distally and produced into two lobes, one a stout, black, curved, tooth-like process lying at the tip of the cymbium, and the other short, flat, and thin-edged. The radix lies at the edge of the cymbium on the mesal side; it is a very large, curved plate, bluntly rounded at base which lies near the tip of the cymbium and is sharply pointed and folded over at the tip which lies at the base of the bulb near the paracymbium. The terminal apophysis is a leaf-like plate pointed at base, convex externally and terminating in two long, sinuous pointed teeth and a slender, transparent and flattened process.

Female.—Length, 2.6-2.8 mm. Similar to male in form and color but with the abdomen larger, generally lighter, but with the same markings. Venter generally greyish.

Eyes are of the same shape and position as in the male but slightly larger and closer together.

The epigynum is a transverse, protuberant plate. The fovea is divided by the scape which is wide at the base with the sides convex, and abruptly narrowed at the middle of the exposed part and continued as a more slender finger-like process. A secondary process extends backward from the scape in a transparent lobe with a cochlear at the tip. The lateral lobes of the epigynum curve toward the middle lobe and overhang it in the center. The openings of the epigynum are limited laterally by the lateral lobes and are situated beneath the scape.

Type locality: Mt. Adams, White Mountains, N. H. Type studied at the Museum of Comparative Zoology.

NEW YORK: Adirondack Lodge, July 24, 1925 (Crosby) 1 ♀; McLean, May 16, 1925, 1 ♀; Cayuga Fauna (Banks) 1 ♂ 1 ♀; Ithaca, Dec., 1 ♀; Chapel Pond, Essex Co., June 27, 1923, 1 ♀. NEWFOUNDLAND: East Coast, Baccaliev

Is., 3 ♂ 1 ♀. QUEBEC: Montfort, June 10, 1916 (J.H.E.) 1 ♀. ONTARIO: 4 mi. E. of Virginia, George T., Yo. Co., Aug. 12, 1931, 2 ♀; Holst Pt., Minaki, July 21-23, 1931, 1 ♀.

In Trans. Royal Can. Inst. 12:319, 1919, Emerton makes *B. duplicatus*, Conn. Acad. Sci. Trans., 1913, equal to *L. subalpinus* which was later found to be an error, according to Jackson, Proc. Zool. Soc. London, p. 154. 1933.

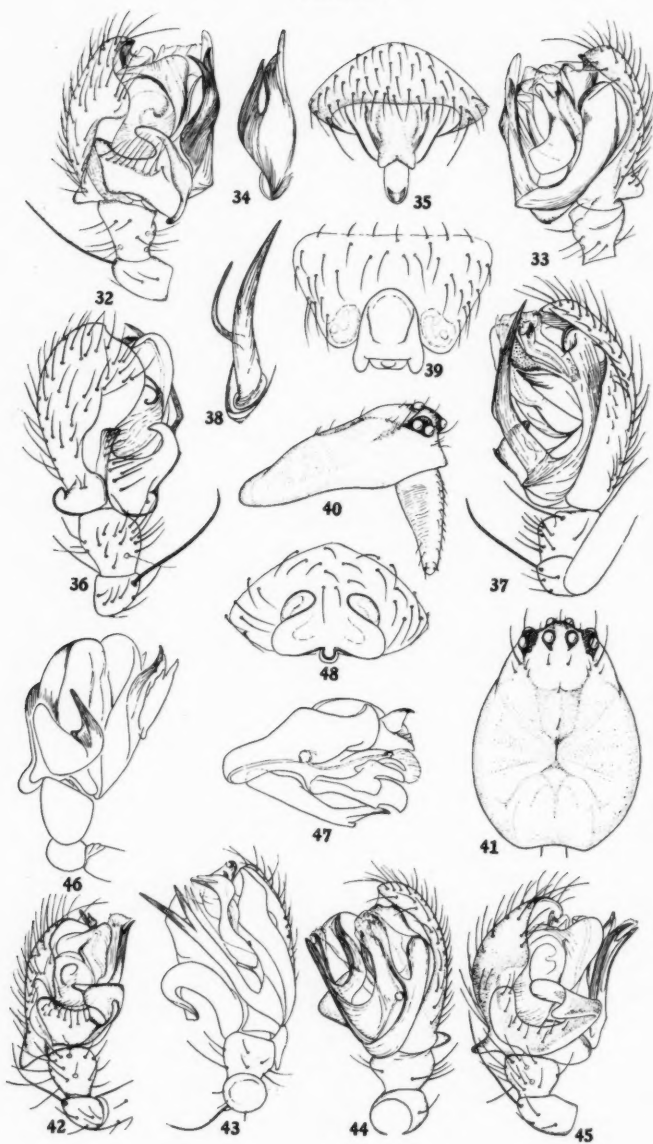
Leptyphantes furcata (Emerton)

Pl. 3, Figs. 36-39

Bathyphantes furcatus Emerton, Conn. Acad. Sci. Trans. 18:218, pl. 2, f. 7. 1913

Male.—Length, 2.5 mm. Cephalothorax yellow suffused with dusky

PLATE 3



darker at the margin and in a shield-shaped patch in front of the dorsal groove; viewed from above moderately broad, evenly rounded on the sides to the cervical grooves, then converging to the bluntly rounded front; viewed from the side, gently arched over the back to the cervical groove where there is a slight depression and then gently arched over the head to the eyes. A group of three or four long stout hairs are back of each posterior eye. The clypeus is nearly straight, slightly protruding. Sternum and labium yellow, slightly suffused with dusky. Endites orange-yellow. Legs yellow, dusky at the distal end of the segments and lightly in a broad band at the middle of the tibiae. Ratio of length of tibia to that of metatarsus as 12 to 11. Both tibia and metatarsus spined. Abdomen above dark with scattered silvery spots, marked with a broad, dark, median basal spot followed by a broad dark chevron and at the tip by three or four alternating narrow, dark and light transverse lines; the sides mottled grey and white with a narrow black-bordered light line separating the darker dorsum from the light grey venter.

Posterior eyes in a straight line, median slightly larger than the lateral, separated by a little less than the diameter and from the lateral by the diameter. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by a little more than the radius and from the lateral by a little more than the diameter.

Femur of palpus rather stout, cylindrical, slightly curved. Patella short, convex above and armed with a long, stout, black spine. Ratio of length of femur to that of patella as 3 to 1. Tibia about as long as wide, protuberant ventrally and with the distal margin above unspecialized. Cymbium viewed from above narrow basally and armed at base above with a stout, curved sharp-pointed process directed laterally and with a short keel-like ridge on the lateral side at the base of the paracymbium. Paracymbium broad at base, very strongly curved, the posterior margin armed with a sharp, curved black tooth beyond which the paracymbium narrows abruptly and is produced into

PLATE 3

Lepthyphantes subalpina

FIGURES

32. ♂, right palpus, lateral view. 34. ♂, terminal apophysis.
33. ♂, right palpus, mesal view. 35. ♀, epigynum, ventral view.

Lepthyphantes furcata

36. ♂, right palpus, lateral view. 38. ♂, terminal apophysis.
37. ♂, right palpus, mesal view. 39. ♀, epigynum, ventral view.

Lepthyphantes calcarata

40. ♂, cephalothorax, lateral view. 42. ♂, right palpus, lateral view.
41. ♂, cephalothorax, dorsal view. 43. ♂, right palpus, ventral view.

Lepthyphantes lyrica

44. ♂, right palpus, mesal view. 45. ♂, right palpus, lateral view.

Lepthyphantes theridiformis

46. ♂, right palpus, lateral view. (after Emerton). 47. ♂, embolic subdivision of left palpus, outside view.
48. ♀, epigynum, ventral view.

a long curved process; this process is the continuation of a ridge extending along the back of the distal half of the paracymbium and curving to the base of the black tooth on the posterior margin. The hollowed out basal part of the paracymbium is armed with a group of long stout hairs. The median apophysis is exposed at the tip of the bulb as a broad, thick, black tipped process with a groove across the tip which divides it into two distinct points. The ventral side of the median apophysis is curved to fit around the greatly swollen and protuberant edge of the tegulum. The radix is strongly developed, broadly expanded at the tip of the bulb to form a knob-like protuberance and at the base of the bulb hollowed out to form a boat-shaped structure. The embolus is slender at base, broadened distally, curved at the tip and terminating in a triangular black point which lies above the tip of the terminal apophysis. Only two distinct sclerites are visible in the unexpanded bulb beyond the embolus; one is basally slender becoming broad and thin and outwardly concave on the basal half, convex distally, the apical part armed with many minute denticles; at about the middle there is a thin, diagonal, minutely aciculate blade-like ridge. This apophysis consists of a very long, strong, spine-like process curved across the face of the bulb, its surface finely aciculate and armed on the lateral side with a long slender curved spine.

Female.—Length, 3 mm. Generally similar to the male in form and color but with the abdomen larger and in some individuals with the pattern strongly developed.

The epigynum is strongly protuberant with a deep triangular notch in the posterior margin of which there is a broad rounded emargination, occupied by a nearly vertical plate bearing a low rounded tubercle in the middle.

Type localities: Passaconaway, New Hampshire and Mt. Mansfield, Vermont. Type studied at the Museum of Comparative Zoology at Cambridge, Mass.

NEW HAMPSHIRE: Base Station, Mt. Washington. Aug. 18, 1925 (Crosby) 1 ♀. NEW YORK: Avalanche Lake, Essex Co., July 24, 1925 (Crosby) 1 ♀; Mt. MacIntyre, Sept. 4, 1927, 1 ♂.

Lepthyphantes calcarata (Emerton)

Pl. 3, Figs. 40-43

Bathypantes calcaratus Emerton, Conn. Acad. Sci. Trans. 14:197, pl. 4, f. 13. 1909; Petrunkevitch, Catalogue, p. 217. 1911; Gibson, Ent. Soc. Ont. Rept. 47:170. 1917; *Lepthyphantes calcaratus* Emerton, Royal Can. Inst. Trans. 12:318. 1919.

Male.—Length, 2.5 mm. Cephalothorax orange-brown suffused with dusky, darker at the margin and with a dusky shield-shaped marking in the center; viewed from above moderately broad, evenly rounded on the sides to the cervical groove where there is a slight constriction, then convergent to the bluntly rounded front; anterior eyes in profile; viewed from the side, depressed, gently arched over the back to the cervical groove, where there is a slight depression, and then gently arched over the head to the eyes. Clypeus concave below the eyes, then convex and gently slanting forward. Sternum and labium yellow-orange to dusky orange. Endites yellow-orange slightly

dusky at base in some specimens. Legs orange-yellow, dusky at the distal end of each segment above. Ratio of length of tibia to that of metatarsus as 60 to 62. Tibia with several spines; no spines on the metatarsi. Abdomen light with scattered silvery spots, and a median basal dark marking followed by three or four dark transverse chevrons; sides usually with a wide dark and narrower light stripe. Venter dusky with a few light spots.

Posterior eyes in a straight line, median slightly larger than the lateral, separated by $\frac{2}{3}$ the diameter and from the lateral by the diameter. Anterior eyes in a slightly recurved line, median smaller than the lateral, separated by the radius and from the lateral by the diameter.

Femur of palpus rather slender, not much thicker distally. Patella short, as wide as long, and armed above near the anterior margin with a long, black, tapering spine. Ratio of length of femur to that of patella as 29 to 12. Tibia simple, a little longer than wide, somewhat constricted at base and with the sides rounded; the distal margin above unspecialized. Paracymbium very broad at base, hollowed out and strongly and evenly curved to form nearly a complete circle, the tip greatly widened, flattened, and produced apically into a bluntly rounded process; basal part of paracymbium armed with several short black hairs. Cymbium, viewed from above narrow at base, sinuous on the lateral side and produced backward at base to form a horn-like process which is finely denticulate. The median apophysis is exposed at the tip of the bulb and consists of a short flat process ending in two points separated by a deep rounded notch. The radix is broad and flat, pointed at base of the bulb, sinuous in outline and widened toward the tip of the bulb and abruptly widened and turned inward at the tip. The embolus lies on the ventral face of the bulb, mesad of the radix and partly over-laid by the processes of the post-embolic division; it is narrow at base, sinuous in outline and the tip lies ventrad of the tip of the median apophysis. In the unexpanded bulb it is possible to make out distinctly only two post-embolic sclerites. The slender terminal apophysis extends diagonally across the face of the bulb and ends in two long, pointed, divergent black teeth. From the base of this apophysis, on the mesal side, a second process extends to the tip of the bulb and partly overlies the embolus. This process is very narrow at base and then widens abruptly and is marked by a transverse, keel-like ridge; it is constricted opposite the base of the embolus, then widened out and with the tip split to form two long processes like the beak of a bird.

Type locality: Portland, Maine, Moosehead Lake, and lower part of Mt. Washington. Type studied at the Museum of Comparative Zoology.

NOVA SCOTIA: Weymouth, Aug. 1924 (Emerton) 3♂.

***Lepthyphantes lyrica* sp. nov.**

Pl. 3, Figs. 44-45

Male.—Length, 1.8 mm. Cephalothorax dark brown, the radiating lines, an angular area on the back of the head and the margin dark gray; viewed from above broad, widest at the second coxae, narrowed forward without a constriction at the cervical groove; anterior eyes in profile; viewed from the

side broadly rounded over the back to the cervical groove, then gently arched over the head to the posterior eyes. Sternum and labium dark gray over dull yellowish. Endites light gray over yellowish white. Chelicerae pale yellow suffused with dark gray on the basal two thirds; sides nearly straight, very slightly divergent at the tip. Legs light yellow, segments beyond the patella more or less gray. Ratio of length of tibia to that of metatarsus as 1 to 1. Abdomen grayish white above with a dark pattern consisting of a basal median area followed by a series of transverse bars; the sides and venter dark.

Posterior eyes in a slightly recurved line, the median a little larger than the lateral, separated by a little less than the radius and from the lateral by the radius. Anterior eyes in a straight line, the median smaller than the lateral, separated by a little more than the radius and from the lateral by nearly the diameter.

Femur of palpus rather short and stout. Patella short, strongly convex above, armed dorsally near the tip with a long spine. Ratio of length of femur to that of patella as 19 to 8. Tibia short and broad, the distal dorsal margin smoothly rounded. Cymbium smoothly rounded over the back, armed at base with a short erect horn. Paracymbium strongly curved, the notch deep, broadly rounded at the bottom, the sides strongly convergent; the basal part broadly rounded in front and armed with five or six stiff hairs, another group of hairs on the horizontal part; the posterior margin raised in a ridge and armed with a tooth; the distal part greatly widened and ending in two points between which the edge is expanded and deeply hollowed out. Median apophysis hidden under the edge of the cymbium where it cannot be seen. Radix constricted near the base mostly from the mesal side; the distal part rather long and curved. Embolus small and delicate. The terminal apophysis wide and band-like, strongly curved and bearing two branches, the lateral one ending in two black points, the mesal one broad, flat, strongly curved and reaching to the tip of the palpus; next to the embolus there is a thin black process.

Holotype, male: Lyre River, Oregon, May 29, 1932 (Kincaid).

Lepthyphantes theridiformis (Emerton)

Pl. 3, Figs. 46-48

Bathyphantes theridiformis Emerton, Conn. Acad. Sci. Trans. 16:396, pl. 3, f. 6. 1911.

Male.—Length, 2 mm. Cephalothorax (in alcohol) orange-yellow with a narrow dark marginal line and a median dark band as wide in front as the posterior row of eyes and tapering to one-half this width at the posterior margin; viewed from above broad, evenly rounded on the sides, with a very slight constriction at the cervical groove and converging anteriorly to the bluntly rounded front; anterior eyes in profile; viewed from the side rather low, steeply ascending behind to the cervical groove, nearly flat on top, then gently rounded over the posterior eyes. Clypeus nearly straight and slightly protruding. Sternum dark grey over orange, widest opposite the second coxae, the sides converging behind, very nearly produced between the hind coxae.

Labium and endites orange-yellow. Chelicerae narrowed and rather strongly divergent distally, the upper margin armed with two rather large teeth. Legs yellow, darkened near the middle and ends of the long segments. Ratio of length of tibia to that of metatarsus as 6 to 5. Abdomen, above, light with a transverse dark marking at the base behind which there is a narrower transverse marking to which it is narrowly connected, and followed by several pairs of irregular dark markings on the posterior half; sides mottled grey and light. Venter dark grey with a lighter marking in the middle region.

Posterior eyes in a straight line, equal, median separated by the radius and from the lateral by a little less. Anterior eyes in a slightly recurved line, median smaller than the lateral, separated by the radius and from the lateral by the diameter.

Femur of palpus nearly straight and cylindrical. Patella short, convex above, and armed disto-laterally with a long strong curved black spine. Ratio of length of femur to that of patella as 21 to 9. Median apophysis is exposed at the tip of the bulb as a large triangular tooth with a curved black tip. Radix is sharply constricted before the base which is somewhat flattened and strongly produced mesally; it is then widened at the middle of its length and gradually narrows to the tip. The embolus is small, very slender, its tip pointed and lying above the base of the radix. Terminal apophysis appears to be of the branching type but in the type specimen the lateral prong seems to be broken off.

Female.—Length, 2.5 mm. Similar to male in form and color but abdomen larger.

Posterior and anterior eyes same relative size, shape and position as in male.

The epigynum is an oval, transverse, protuberant plate. The scape is narrow at the base, abruptly widening behind where it is broadly emarginate and ends in a small process overlying a secondary one. The sides of the epigynum converge behind in such a manner that the scape overlies them behind.

Type: Jackson, New Hampshire. Holotype ♂ June 1, 1910, paratype ♀, same date.

NEW HAMPSHIRE: Jackson, June 1, 1910 (Emerton) 1 ♀; Intervale, July 30, 1911 (Emerton) 1 ♀; Moosilauke, July 4, 1912 (Emerton) 2 ♀; Three-Mile Island, June 1, 1909 (Emerton) 1 ♀.

Leptyphantes washingtoni nom. nov.

Pl. 4, Figs. 49-52

Bathyphantes duplicatus Emerton, Conn. Acad. Sci. Trans. 18:217, pl. 2, f. 6(c). 1913; *Leptyphantes complicatus* Jackson, Zool. Soc. London Proc. pt. 1, p. 154, pl. 1, ff. 6-10. 1933.

Male.—Length, 2.4 mm. Cephalothorax light grey over dull orange yellow, darker towards the margin; viewed from above rather broad, rounded on the sides to the front of the front coxa, not constricted at the cervical groove; anterior eyes in profile; viewed from the side low, gently ascending behind to

the cervical groove where there is a shallow depression, then gently rounded over the head to the posterior eyes. Clypeus slightly convex beneath the eyes, gently slanting forward. Sternum and labium dark brown, nearly black. Endites honey yellow, slightly greyish. Chelicerae lightly suffused with greyish yellow, nearly straight, slightly divaricate at the tip. Legs straw yellow, tibia slightly shorter than the metatarsus. Abdomen pale above with flecks of white, a dark lanceolate basal stripe followed by a double row of dark spots, an irregular dark stripe on the side narrowly connected with one of the posterior dorsal spots; venter dark with flecks of white.

Posterior eyes in a slightly recurved line, the median separated by a little less than the radius and a little farther from the lateral. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by two-thirds the diameter and from the lateral by a little more than the diameter.

Femur of palpus rather stout, slightly thicker distally. Patella short, narrower than femur, convex above, armed dorso-laterally near tip with a long black spine. Ratio of length of femur to that of patella as 30 to 10. Tibia short, greatly swollen ventro-laterally, the dorsal margin thin and upturned, and smooth. Cymbium smoothly rounded over the back, but with an erect tooth-like projection dorsally at base and a very small protuberance on the dorso-mesal side at base. Paracymbium broadly attached at base where it is armed with a bunch of about ten long stiff hairs, the posterior margin forms a black ridge which ends laterally in an acute black tooth, the outer arm ends in a sharp point and bears on its inner face a very long process, broad at base, thin, narrower and transparent at tip and armed on the side towards the cymbium with a stout black tooth. Median apophysis has the tooth stout, black, curved, the edge is thin and frayed but a curved black line shows through it from the other side. Radix slightly constricted from the inside near the base, the distal part very large, pointed, the vesicle of the duct pyriform. Embolus very broad and thin, basally rounded, the two flanges spirally twisted, apex thin, broad, rounded, with a minute tooth on the edge. Terminal apophysis narrow at base, then expanded into a convex blade, the end is acuminate, the margin concave with a sharp tooth on the lateral side and three teeth at the mesal angle, between the teeth the margin is finely denticulate.

Female.—Length, 2.8 mm. Generally similar to the male in form and color, but with the abdomen larger and the legs sometimes banded. The median dark mark on the dorsum of the abdomen with several pairs of short lateral branches which are widened and rounded distally.

The epigynum is strongly protuberant ventrally, provided anteriorly with a median, roughly triangular plate which is continued backward as a thin ridge with a nearly straight edge. The backward projection of the median ridge is bordered each side by a rounded flange at a lighter level.

Type locality: Mt. Washington, N. H., on the Raymond path.

COLORADO: Stormy Peaks, Pingree Park, Aug. 20, 1924 (Crosby) 2♂.
NEW YORK: Mt. Whiteface, Aug. 24, 1916 (Bishop) 1♂; Aug. 25, 1921, 1♀.

LABRADOR: Ungava Bay, Akpatok Island, Apr. 1932 (Jackson) 1♂ 1♀; Asswan River to Cabot Lake, Sept. 1921 (Waugh) 3♂ 3♀.

Emerton, in 1913, indicated two type localities for *Bathypantes duplicata* Emerton, i.e. Mt. Katahdin, Maine and Mt. Washington. N. H. Jackson, in 1933, found that specimens from Labrador agreed with Emerton's type from Mt. Washington but not with the Mt. Katahdin material. He therefore designated the Mt. Katahdin form as type of *Bathypantes duplicata* Emerton and the Mt. Washington specimens as the type of a new species which he named *Leptyphantes complicatus*. Unfortunately, this name cannot be retained because *Bathypantes complicatus* Emerton, 1882, has been found to belong to *Lepthyphantes*.

I wanted to rename this species for Mr. Jackson but a species bearing his name has already been described by Schenkel, 1925.

The description given above, is based upon specimens like the type from Mt. Washington, compared at Cambridge, Mass., June 9, 1935.

Lepthyphantes duplicata (Emerton)

Pl. 4, Figs. 53-54

Bathypantes duplicatus Emerton, Conn. Acad. Sci. Trans. 18:217, pl. 2, f. 6 (b). 1913; *Bathypantes duplicata* Jackson, Zool. Soc. London Proc. pt. 1, p. 154. 1933.

Male.—Length, 2.2 mm. Cephalothorax orange suffused with dusky and slightly darker radiating lines at the margin; viewed from above evenly rounded on the sides, slightly constricted at the cervical groove and the sides converging to the bluntly pointed front; anterior eyes in profile; viewed from the side evenly and broadly rounded over the back to the cervical groove and then broadly rounded over the back of the head to the posterior eyes. Clypeus slightly convex and rather strongly protruding. Sternum and labium orange strongly suffused with dusky; sternum rather strongly convex and narrowly produced between the hind coxae and squarely truncate behind. Endites orange at base, lighter distally. Legs orange. Femora and tibiae with indistinct greyish bands at the center and distal ends. Ratio of length of tibia to that of metatarsus as 55 to 51. Tibia and metatarsus spined. Abdomen with light grey ground color, marked above with a broad dark central figure followed by several dark transverse bars; tip dark; the sides with a light and a dark stripe. Venter dark grey.

Posterior eyes in a straight line, equal, median separated by a little more than the diameter and from the lateral by about two-thirds the diameter. Anterior eyes in a slightly procurved line, median smaller than the lateral, separated by less than the radius and from the lateral by the diameter.

Femur of palpus moderately long and stout, slightly enlarged distally and curved inward at the base. Ratio of length of femur to that of patella as 30 to 10. Patella short, strongly convex above, armed above near the distal margin with a long, strong, curved spine finely roughened toward the tip. Tibia short with the distal margin nearly straight and strongly swollen distolaterally. The cymbium is smoothly rounded over the back, angulate at the base on the lateral side; this angle is more blunt than in *jacksoni*. The paracymbium is broadly attached at the base and rather narrow and strongly rolled on itself, broadly and deeply grooved and has a blunt triangular tooth on the outer flange on the posterior side near the base. The tip of the main

PLATE 4



49



52



50



51



58



54



59



56



53



62



55



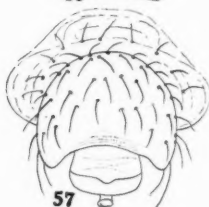
60



63



61



57

part ends in two small blunt black teeth with a little rounded notch between them. From the inner side of the paracymbium at the tip there arises a thin leaf-like process which has two ridges, the one along the margin next to the base of the paracymbium ends in a blunt point, and another thinner ridge on the opposite side on the narrower tip. The median apophysis has the tooth rather short and black accompanied on the side next to the cymbium by a slender acute tooth which is shorter than in *jacksoni*; the opposite angle has the edge chitinated, upturned and minutely crenulate. Radix strongly constricted before the tooth, the basal end widened, appearing rounded, the tip incurved; the distal end is hollowed out and boat-shaped. The terminal apophysis is long, thin, ribbon-like, longitudinally aciculate and terminates in two blackish points between which there is a deeply rounded notch; the lateral point is more slender and its tip is squarely truncated; the mesal point is broader and irregularly dentate on the inner side. From the base of the median apophysis on the mesal side there arises a process which is thin and crumpled in the basal half; its distal part is blade-like and directed transversely across the bulb with a black angle at the bend. The next process lying nearest the embolus is black, rounded at the base, pointed and truncate at the tip and strongly curved laterally.

Type locality: Mt. Katadin, Maine. (2000 ft., July 6, 1910). Described from the type studied at the Museum of Comparative Zoology at Cambridge, Mass.

Lepthyphantes complicata (Emerton)

Pl. 4, Figs. 55-57

Bathypantes complicata Emerton, Conn. Acad. Sci. Trans. 6:72, pl. 24, f. 8. 1882; *Bathypantes complicatus* Petrunkevitch, Catalogue, p. 217. 1911.

Male.—Length, 1.8 mm. Cephalothorax yellow, suffused with dusky, darker at the margin; viewed from above broad, evenly rounded on the sides, convergent toward the front; anterior eyes in profile; viewed from the side,

PLATE 4

FIGURES

Lepthyphantes washingtoni

- | | |
|---------------------------------------|--------------------------------|
| 49. ♂, right palpus, dorsomesal view. | 51. ♂, paracymbium. |
| 50. ♂, right palpus, ventral view. | 52. ♀, epigynum, ventral view. |

Lepthyphantes duplicata

- | | |
|----------------------------|---------------------|
| 53. ♂, terminal apophysis. | 54. ♂, paracymbium. |
|----------------------------|---------------------|

Lepthyphantes complicata

- | | |
|------------------------------------|------------------|
| 55. ♂, right palpus, ventral view. | 57. ♀, epigynum. |
| 56. ♂, paracymbium. | |

Lepthyphantes fructuosa

- | | |
|------------------------------------|------------------------------------|
| 58. ♂, right palpus, lateral view. | 59. ♂, right palpus, ventral view. |
|------------------------------------|------------------------------------|

Lepthyphantes bihamata

- | | |
|----------------------------------|--------------------------------|
| 60. ♂, right palpus, mesal view. | 62. ♂, paracymbium. |
| 61. ♂, terminal apophysis. | 63. ♀, epigynum, ventral view. |

cephalothorax steeply ascending behind to the cervical groove where there is a slight depression and then very gently arched over the head to the eyes. Clypeus straight, slanting forward. Sternum and labium dark grey. Endites yellow, slightly dusky distally. Legs yellow, tibiae slightly dusky. Ratio of length of tibia to that of metatarsus as 64 to 54. Metatarsus and tibia spined. Abdomen with small scattered spots on a dark grey background. Venter dark grey.

Posterior eyes in a slightly recurved line, equal, the median separated by the radius and from the lateral by a little less. Anterior eyes in a straight line, median smaller than lateral, separated by the radius and from the lateral by a little more.

Femur of palpus rather slender, moderately long, nearly cylindrical. Patella short and broad, armed dorso-laterally with a long, strong, curved spine. Ratio of length of femur to that of patella as 23 to 7. Tibia short, viewed from the side not much swollen below, slightly angulate above back from the margin, armed dorsally back of the angle with a long black spine, the dorsal margin broadly rounded, broadly excavated dorso-laterally and expanded laterally into a round lobe to fit the paracymbium. Cymbium rounded over the back, without protuberances. Paracymbium rather broadly attached at base and armed with an irregular row of stiff hairs, strongly curved, forming a deep narrow notch, and deeply grooved, the outer flange armed opposite the lateral tibial lobe with a sharp triangular tooth, and with a smaller tooth on the outer arm; only the upper edge is dark; the rest of the paracymbium including the tip is almost transparent, tip separated from the upper flange by a deep notch, broad and rounded at the end and crossed next to the notch by a high ridge rounded above. Median apophysis has the whole end produced into a single, long, stout, acute tooth. Radix moderately constricted before the tooth, broadly rounded at the end, merely curved, not bent at the middle, the distal end broad, squarely truncate, the vesicle of the duct relatively large. Embolus curved across the face of the bulb, narrow at base and armed with three spine-like teeth; broad in the middle part, the flanges smooth, the tip ends in two points one above the other, the duct opening in the outer one. Terminal apophysis an extremely long, thin, ribbon-like band that lies loose from the bulb; the tip lies near the end of the embolus, it is acute and serrate on the outer side.

Female.—Length, 2 mm. Cephalothorax slightly darker than in the male, but smaller. Viewed from above, the anterior eyes in profile. Abdomen larger than in the male but the same color. Venter dark grey.

The epigynum is a very protuberant, oval plate. The fovea, seen posteriorly is divided by a broad scape, very narrow at the base and widened just beyond the base and then folded under and back again so that the narrow tip only is exposed.

Type locality: Mt. Washington, New Hampshire, June 10, 1877. Type studied at the Museum of Comparative Zoology at Cambridge, Mass.

NEW YORK: Chapel Pond, Oct. 20, 1934 (C.R.C.) 3♂; Artist Brook, Essex Co., Sept. 7, 1931 (C & M) 1♂ 2♀; June 11, 1933 (Crosby) 3♂ 8♀; Mt. Whiteface, Sept. 13, 1931 (Hammer) 1♂; Aug. 25, 1925, 1♂; Oct. 21, 1934, 4♂ 3♀; Avalanche Lake, July 25, 1925 (S.C.B.) 1♀; July 24, 1925, 1♀; Up-

hill Brook, near Opalescent River, July, 1918 (Crosby) 1♂; Mt. McIntyre, Essex Co., July 1, 1923 (C.R.C.) 4♀. CANADA: Alberta, Lake Louise, Aug. 3, 1927 (Crosby) 1♂; Banff, Sulphur Mt., Aug. 2, 1927 (Crosby) 1♀; Terrace, Mar., 1933, 1♂ 2♀.

Lepthyphantes fructuosa (Keyserling)

Pl. 4, Figs. 58-59

Linyphia fructuosa Keyserling, Spinnen Amerikas, Theridiidae, 2:72, pl. 13, f. 171. 1886; *Bathypantes occidentalis* Emerton, Conn. Acad. Sci. Trans. 20:151, pl. 2, f. 11. 1915; Gibson, Ent. Soc. Ont. Ann. Rept. 46:229. 1916; Worley, Univ. Wash. Publ. 1:28. 1932; *Lepthyphantes occidentalis* Emerton, Royal Can. Inst. Trans. 12:319. 1919.

Male.—Length, 1.6-2.1 mm. Cephalothorax orange yellow, strongly suffused with dusky on the back of the head and along radiating lines, margin nearly black, a rectangular area back of the eyes lighter; viewed from above broad, evenly rounded to the second coxae and then narrowed forward without a constriction at the cervical groove; anterior eyes in profile; viewed from the side, low, ascending moderately behind to the cervical groove where there is only a slight depression, then gently rounded over the head to the posterior eyes. Clypeus straight and slanting forward. Sternum gray over orange yellow, darker posteriorly, margin narrowly black. Labium dark. Endites orange yellow. Chelicerae orange yellow, slightly divergent at the tip. Legs long, yellow, the patellae, the median bands on the tibiae and metatarsi and at the tip of metatarsi dusky, joints dusky. Ratio of length of tibia to that of metatarsus as 1 to 1. Abdomen with a basal and lateral black band, upper surface white with a black pattern consisting of a short median stripe in front expanded posteriorly to form a large triangular spot followed by a series of chevrons, the first two much heavier than the others; below the lateral stripe is a sublateral white stripe. Venter gray. This description is made from a well colored specimen; in some others the posterior part of the pattern is obsolete.

Posterior eyes in a slightly recurved line, the median separated by a little less than the diameter and from the lateral by the diameter. Anterior eyes in a slightly procurved line, the median smaller than the lateral, separated by the radius and from the lateral by a little more than the diameter.

Femur of palpus rather short and thick. Patella short, straight below, convex above, armed dorsally near the tip with a very long fine spine. Ratio of length of femur to that of patella 21 to 7. Tibia short but longer than in *bihamata*. Cymbium smoothly rounded over the back, armed at base with an erect horn, its tip sharply curved forward. Paracymbium broad at base where it is armed with a row of seven or eight fine stiff hairs, the posterior margin raised in a ridge but not armed with a tooth; the outer arm branched as in *bihamata*, the outer branch broad at base, oblique, posterior edge convex, the anterior concave, the tip black, acute; the inner branch rather short, broad, gradually narrowed, rounded at tip. Median apophysis has the whole

distal end chitinized, the tooth rather short, curved. Radix rather broad, constricted where it lies over the edge of the tegulum, angulate on lateral side near base, the distal part greatly widened on the lateral side, the front margin of this projection then sharply angulate; the terminal apophysis long and slender, somewhat broader at base, the terminal part folded lengthwise to form a half cylinder, the tip expanded and armed with a series of rather coarse teeth.

Type locality: Vancouver, Canada.

WASHINGTON: Lake Sutherland, Aug. 11, 1927 (Crosby) 5♂; Friday Harbor, Aug. 5, 1926, 2♂; La Push, Aug. 10, 1927 (Crosby) 1♂.

ALASKA: Admiralty Island, June, 1933 (Sheppard) 3♂ 1♀.

Lepthyphantes bihamata (Emerton)

Pl. 4, Figs. 60-63

Bathyphantes bihamata Emerton, Conn. Acad. Sci. Trans. 6:72, pl. 23, f. 4. 1882.

Male.—Length, 1.6 mm. Cephalothorax (probably discolored) dark reddish brown with the radiating lines and angular area on the back of the head gray; viewed from above broadest at the second coxae and then narrowed forward without any constriction at the cervical groove; head narrow in front, all the eyes except the posterior median in profile; viewed from the side rather low, ascending steeply behind to the cervical groove, nearly flat on top, then gently rounding over to the posterior median eyes. Sternum and labium nearly black. Endites dusky orange yellow. Chelicerae reddish brown, nearly straight. Legs and palpi light orange yellow. Ratio of length of tibia to that of metatarsus at 1 to 1. Abdomen dull gray above with a dark pattern consisting of a median area in front, lateral spots and a series of transverse bars posteriorly; sides of abdomen dull, dirty white, on the anterior half a short dark bar. Venter dark gray.

Posterior eyes in a slightly recurved line, the median separated by the radius and a little farther from the lateral. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by two-thirds the diameter and from the lateral by the radius.

Femur of palpus rather short and thick. Patella short, straight below, strongly convex above, armed dorsally near the tip with a long spine. Ratio of length of femur to that of patella as 17 to 7. Tibia short and broad, swollen ventro-laterally, the dorsal margin smooth. Cymbium smoothly rounded over the back, armed on the mesal side at base with an erect horn slightly constricted at base. Paracymbium strongly curved enclosing a deep notch, the sides of which are distinctly convergent; basal part of the paracymbium rather broad and armed with a row of fine stiff hairs, armed with a black triangular tooth on the posterior margin next to the edge of the tibia; at the base of the lateral arm the outer ridge is developed into a very large, thin, erect, triangular tooth or branch. Tooth of median apophysis short, broad at the base, curved; the opposite angle has a thinner, broader but similar tooth. Radix rather broad throughout, only slightly constricted at the

base. Embolus small, thin and delicate. Beyond the embolus the radix bears three processes; the first is broad and thin at base, and appearing in the side view forked at the tip; the second is long, slender, curved and acute at the tip; the third, or terminal apophysis, lies between the paracymbium and the tegulum, and is much shorter, narrow at base, greatly widened, the lateral side is chitinated and ends in a black mucronate point, the mesal side is very thin, hyaline, the distal margin frayed and aciculate.

Female.—Length, 2 mm. Similar to the male but the pattern on the back of the abdomen much more distinct; a black band across the front extends back on each side about a quarter of the length, the central dark pattern consists of a trifolium in front connected with a series of transverse bars surrounded by a white area formed by white flecks showing through the integument. Venter grey to black, usually lighter in the middle.

The epigynum moderately protuberant; the scape rather broad at base, then greatly widened, curved inward towards the venter, folded under itself and then out again so that only the tip of the narrow terminal part is visible in a notch on the posterior side of the middle part; the pyriform openings on each side of the base of the scape rather widely open behind.

Type locality: Lower part of Mt. Washington, N. H.

QUEBEC: Montfort, June 10, 1916, (Emerton) 4♂ 6♀.

Lepthyphantes arborea (Emerton)

Pl. 5, Figs. 64-66

Bathypantes arborea Emerton, Conn. Acad. Sci. Trans. 20:151, pl. 2, f. 10. 1915; Gibson, Ent. Soc. Ont. Rept. 46:229. 1916; *Lepthyphantes arborea* Emerton, Royal Can. Inst. Trans. 12:318. 1919.

Male.—Length, 2.2 mm. Cephalothorax dull yellow, strongly suffused with dusky, darker at the margin and in a shield-shaped spot in front of dorsal groove; viewed from above moderately broad, evenly rounded on the sides, constricted at the cervical groove, broadly rounded across the front; anterior eyes in profile; viewed from the side, gently arched over the back to the cervical groove where there is a slight depression and then gently arched over the head to the eyes. Clypeus slightly convex and protruding. Sternum and labium dark, nearly black over yellow ground color. Endites yellow, slightly dusky posteriorly. Legs yellow, in some individuals slightly dusky at the middle and end of each segment. Ratio of length of tibia to that of metatarsus as 73 to 72. In the type, abdomen light with scattered silvery spots, marked by a dark median longitudinal stripe with several lateral projections, tip dark, the sides with a dark and light stripe. Venter dark gray. In a male from Yellowstone Park the abdomen is quite uniform yellowish grey with faint paired spots on the distal half.

Posterior eyes in a straight line, equal and equidistant, separated by three-fifths the diameter. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by a little less than the diameter and from the lateral by the diameter.

Femur of palpus moderately stout, nearly cylindrical, slightly curved inward distally. Patella short, convex above and armed with a long black spine, stout at base, and apically slender and barbed. Ratio of length of femur to that of patella as 21 to 9. Tibia armed with a smaller apically slender spine proceeding ventrally from a slight protuberance. Tibia short, widened distally, about as long as wide and with the dorsal margin unspecialized. Cymbium with the dorso-lateral angle at base produced into a flattened, quadrate process bearing a tooth on the basal angle. Paracymbium with the basal half broad and somewhat hollowed out, armed at base with a group of about 10 short hairs; the paracymbium bent strongly upon itself at about the middle of its length, the distal half ending in two bluntly rounded and flattened lobes separated by a sharp keel-like ridge and a very large, black, pointed tooth which arises at the bend of the paracymbium on the posterior margin. The median apophysis is exposed at the tip of the bulb as a stout, curved black tooth; the radix is large and broad, bluntly rounded and flattened basally, produced apically into a flat and bluntly rounded lobe and armed on the lateral side near base with a long strong pointed tooth; the embolus is a slender pointed process with a minute tip. The post-embolic division consists of three, at least, separate sclerites; one, a triradiate piece lying at the tip of the bulb and more or less continuous with a leaf-shaped sclerite at the base of the radix on the lateral side; the terminal apophysis consists of a long process which curves across the ventral face of the bulb, broad at base, slender apically and divided at tip into two unequal arms the shorter of which ends in two sharp points.

Female.—Length, 2.5-2.8 mm. Similar to male in form and color, but the abdomen larger and lighter.

Posterior eyes in a slightly recurved line, equal, the median separated by three-fifths the diameter and from the lateral by a little more. Anterior eyes in a very slightly recurved line, median smaller than the lateral, separated by the diameter and from the lateral by a little more.

The epigynum is an oval, transverse, protuberant plate. The scape is constricted at base, then abruptly widened to form two broadly rounded lobes which extend nearly to the posterior margin of the epigynum; the scape is folded dorsally then produced ventrally, its tip extending beyond the paired lobes of the first fold.

Type locality: Banff, Laggan, Yoho Valley up to 7000 ft. Type studied at the Museum of Comparative Zoology.

WASHINGTON: Mt. Ranier, Paradise Camp, Aug. 19, 1927, 2♀. WYOMING: Yellowstone Pk., West Thumb, Aug. 4, 1927, 1♀; Grand Canyon, Aug. 30, 1927 (Crosby) 1♂; Grand Teton Pass, July 4, 1933 (Crosby) 2♀. ALASKA:

Mole Harbor, Adm. I., July 30, 1932 (Hasselborg) 1♀; Admiralty Island, June, 1933 (Sheppard) 2♂ 2♀. ALBERTA: Banff, Sulphur Mt., Aug. 2, 1927, 2♀.

Leptyphantes zebra (Emerton)

Pl. 5, Figs. 67-72

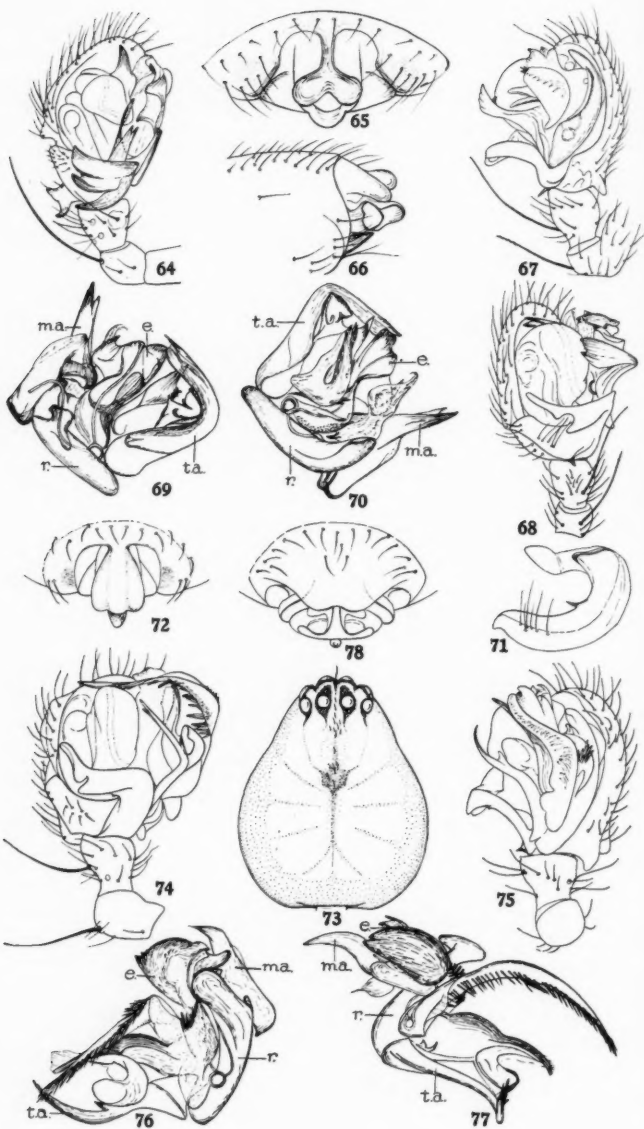
Bathyphantes zebra Emerton, Conn. Acad. Sci. Trans. 6:69, pl. 22, f. 2. 1882; Psyche 16:96. 1909; Ent. News 30:167. 1919; Banks, N. Y. Ent. Soc. Jour. 3:88. 1895; Phila. Acad. Sci. Proc. 1911, p. 448; Elliott, Ind. Acad. Sci. Proc. 41:425. (1931) 1932; *Bathyphantes argenteomaculata* Banks, Phila. Acad. Sci. Proc. 1892, p. 45; *Bathyphantes alpina* Banks, Phila. Acad. Sci. Proc. 1892, p. 42; *Bathyphantes sabulosa* Banks, ibid., p. 45; Phila. Acad. Sci. Proc. 1916, p. 76; *Leptyphantes zebra* Emerton, Royal Can. Inst. Trans. 12:319. 1919.

Male.—Length, 2 mm. Cephalothorax yellow, lightly suffused with grey, slightly darker at the margin; viewed from above rather broad, evenly rounded on the sides to the cervical groove, convergent towards the front; the anterior eyes in profile; viewed from the side, broadly rounded over the back to the cervical groove and then gently arched over the head to the eyes. Clypeus concave below the eyes, then nearly straight and slightly protruding. Sternum and labium dark grey over a yellow ground color. Endites yellow, very lightly dusted with grey. Legs light yellow. Ratio of length of tibia to that of metatarsus as 70 to 66. Tibiae and metatarsi of the legs spined above. Abdomen light with scattered silvery spots and marked with three or four dusky bands; the tip dark; the sides with a dark and light stripe. Venter dark grey.

Posterior eyes in a slightly recurved line, equal and equidistant, separated by the radius. Anterior eyes in a very slightly recurved line, the median smaller than the lateral, subcontiguous and separated from the lateral by the diameter.

Femur of palpus a little thicker at the third quarter and slightly curved inward. Patella short, convex above and armed with a long black spine that is barbed at the tip. Tibia moderately swollen below, viewed from above both sides convex, the distal margin smooth and nearly straight and armed dorsally with a long black spine. Cymbium rounded over the back with a slight pointed projection at the base on the mesal side. Paracymbium strongly bent to form a deeply rounded notch; a group of eight or nine stiff hairs on the face of the basal part; a small black tooth on the posterior rim and another on the upper flange in the bottom of the notch; the tip narrow, spatulate, bent toward the bulb and separated from the rest of the paracymbium by a small rounded notch. Median apophysis is thin, flat, broad, and tapers gradually to an acute point with one or two minute teeth on the side near the tip. Radix slightly narrower beyond the tooth, tip rounded. Embolus broad and thin, basal half vertical, and the terminal half rotated one half turn, the outer surface of the basal half with minute black granulations; the terminal part is finely aciculate, the tip rounded, the duct opening through a minute black tooth on the side next to the cymbium. The terminal apophysis is represented by three elements, the process next to the embolus curved at base and armed at the sides with a long black tooth; the next process arises from the base of the first and is rather thin, toothed, and ends in a sharp point; the third is small and appears spatulate; the terminal apophysis appears narrow at the base, thin, long, curved, widened distally and the tip diagonally rounded

PLATE 5



and frayed. On the inner side and showing through is a diagonal ridge bearing a small triangular tooth.

Female.—Length, 2 mm. Similar to male in form and color but cephalothorax slightly narrower and abdomen larger. The colors of the abdomen are generally lighter than the male and with the darker blotches less well defined. Venter light except at the tip which is slightly darker.

The epigynum is an oval transverse plate. The scape is constricted at the base, gradually broadened distally, the sides slightly convex and apparently truncated where it is folded slightly forward; it is again folded backward so that the terminal part lies below the first fold with only the tip exposed. The lateral lobes of the epigynum are narrow and are curved inward toward the scape posteriorly leaving a crescent-shaped opening on each side of the scape.

Type locality: Eastern Massachusetts and New Haven, Conn. The type has been studied at the Museum of Comparative Zoology.

CONNECTICUT: Wachocastinook Crk., June 29, 1930, 3♀. MAINE: Sebasticook Lake, Aug. 25, 1924, 1♀; Molunkus Pond, Aug. 25, 1925, 1♀; Presque Isle, Aug. 16, 1925, 1♀. MASSACHUSETTS: Mt. Wachusett, Oct. 29, 1932 (Crosby) 3♂ 3♀; Mt. Greylock, Oct. 2, 1927 (Bishop) 2♀. MICHIGAN: Albion, May 12, 1933 (Chickering) 1♂ 2♀; Victory Park, Dec. 18, 1933 (Chickering) 2♂ 1♀; Albion, Oct. 8, 1932 (Chickering) 1♀; Duck Lane, Oct. 1, 1932 (Chickering) 2♀; Albion, Oct. 20, 1932 (Chickering) 3♂ 4♀; Schultz Woods, Albion, Apr. 24, 1933 (Chickering) 2♀; Winnipeg Lake, Oct. 15, 1932 (Chickering) 3♂ 3♀.

NEW YORK: Tuxedo, Oct. 4, 1925 (Wolf) 1♂ 1♀; Crosby, Dec. 1905, 6♂ 5♀; Richburg, Sept. 16, 1925, 1♂ 1♀; Old Forge, Oct. 24, 1922, 2♀;

McLean, Apr. 17, 1925, 1♀; May 16, 1925, 2♀; July, 1904, 1♂ 2♀; Apr. 24, 1924 (Crosby) 2♀; Apr. 30, 1930, 1♀; Oct. 13, 1934 (Crosby) 2♂ 4♀; Auger Pond, Essex Co., Nov. 17, 1916, 1♂; Watkins Glen, Oct., 1918, 2♂ 3♀; Eggleston's Glen, Yates Co., Sept. 24, 1920, 3♂; Oct., 1918, 1♀; Ithaca, Dec. 7, 1912, 1♂ 1♀; Dec. 12, 1918, 1♂; Nov. 19, 1925, 4♂ 3♀; Mar., 3♂; Jan., 1♀; Nov., 6♂ 5♀; May, 1♂ 2♀; Oct., 4♂ 3♀; Troy, 1912, 1♀; Ithaca, Sept. 24, 1922, 2♂ 1♀; Ringwood, May 20, 1919 (Dietrich) 2♂ 1♀; Sept. 24, 1933 (Crosby) 3♀; Slaterville, May 10, 1925 (C.C. & S.) 3♀; (P.R.N. & R.H.) 1♂; Slide Mt., Ulster Co., May 8, 1921, 1♀; June 24, 1934, 1♀; Aug. 9, 1923, 2♀; Wilmington Notch, July 5, 1923, 2♀; Aug. 21, 1916, 1♂; Oct. 23, 1934, 1♂ 3♀;

PLATE 5

Leptyphantes arborea

FIGURES

64. ♂, right palpus, lateral view.

65. ♀, epigynum, ventral view.

66. ♀, epigynum, lateral view.

Leptyphantes zebra

67. ♂, right palpus, mesal view.

68. ♂, right palpus, lateral view.

69. ♂, embolic subdivision of right palpus, inside view.

70. ♂, embolic subdivision of right palpus, outside view.

71. ♂, paracymbium.

72. ♀, epigynum, ventral view.

Leptyphantes sabulosa

73. ♂, cephalothorax, dorsal view.

74. ♂, right palpus, lateral view.

75. ♂, right palpus, mesal view.

76. ♂, embolic subdivision of right pal-

pus, outside view.

77. ♂, embolic subdivision of right palpus, inside view.

78. ♀, epigynum, ventral view.

Stamford, May 30, 1921 (H.P.C.) 1 ♀; Connecticut Hill, Tompkins Co., Oct. 19, 1924, 4 ♂ 6 ♀; Sterlington, May 18, 1924, 1 ♀; Enfield Glen, Oct. 10, 1920, 4 ♀; Apr. 12, 1930, 1 ♂ 7 ♀; Ithaca, Apr. 24, 1931 (Hughes) 2 ♀; Mar. 7, 1925 (Babiy) 1 ♂; Mar. 5, 1932 (Crosby) 2 ♂ 5 ♀; Oct. 14, 1934 (Crosby) 1 ♀; Oakland Valley, May 26, 1920, 2 ♀; Presho, Oct. 29, 1924, 1 ♂; Shurgers Gorge, Nov. 24, 1918, 1 ♂ 6 ♀; Whiteface Mt., Aug. 22, 1916, 1 ♂ 1 ♀; Sept. 13, 1931 (Hammer) 1 ♂ 2 ♀; Lake Keuka, June, 1904, 1 ♀; Cayuga region (Banks) 5 ♀; Ancram, June 11, 1919, 1 ♀; Crosby, Dec. 1905, 2 ♂; Charley Lake, Hamilton Co., Apr. 27, 1923, 4 ♀; Ceres, Sept. 16, 1925, 1 ♀; Piseco Lake, Hamilton Co., Apr. 27, 1923, 2 ♀; Johns Brook, Mt. Marcy Aug. 25, 1930 (Crosby) 1 ♂; West Danby, Oct. 9, 1932 (Crosby) 1 ♀; Danby, Oct. 2, 1932 (Crosby) 1 ♀; 1 ♀; Black Brook, June 10, 1933 (Crosby) 1 ♀; Bolton, June 8, 1933 (C. & D.) 1 ♀; Lake Charlotte, June 11, 1919, 1 ♀; Fish Pond Crk. (C. & M.) 3 ♀; Pawling, Apr. 19, 1931 (Crosby) 1 ♀; Wells, Apr. 27, 1923 (Crosby) 8 ♀; Avalanche Lake, July 25, 1925 (S.C.B.) 1 ♀; Whetstone Gulf, Lewis Co., Sept. 2, 1926, 1 ♀; Penn Yan, May 4, 1922, 1 ♀; Indian Lake, Oct. 19, 1934 (Cros-

by) 4 ♂ 4 ♀; Raquette Lake, Oct. 23, 1934 (Crosby) 1 ♀; Burnt Hill, Clinton Co., Oct. 19, 1935 (Crosby) 2 ♂ 1 ♀.

NORTH CAROLINA: E. Fork, Pisgah River, Oct. 14, 1926, 1 ♀; Big Bald, Pisgah Range, Oct. 13, 1926, 1 ♀; Blowing Rock, Oct. 10, 1923 (C. & B.) 3 ♂ 2 ♀; Grandfather Mt., Oct. 12, 1923, 11 ♂ 8 ♀; Aquone, Oct. 16, 1926, 1 ♀; Highlands, Apr. 5, 1929, 3 ♀; Fry- ing Pan Gap, Mt. Pisgah, Oct. 10, 1926, 9 ♂ 9 ♀; Mt. Mitchell, Oct. 22, 1923 (C. & B.) 39 ♂ 19 ♀. TENNESSEE: Mill Crk., near Falls, LeConte, Oct. 10, 1926, 11 ♂ 9 ♀; Top of Mt. LeConte, Oct. 10, 1926, 16 ♂ 25 ♀; Laurel Crk., Sevier Co., Oct. 8, 1926, 1 ♀. VERMONT: Pittsford, May 8, 1929, 2 ♀; Smugler's Notch, June 14, 1927 (Crosby) 1 ♂. WASHINGTON: Sol Duc Hot Springs, Aug. 12, 1927, 3 ♂ 11 ♀. CANADA: Alberta, Edmonton, Aug. 16, 1924 (Crosby) 1 ♂; Ontario, Sanford, June (Crosby) 4 ♀; British Columbia, Aleza Lake, Sept. 1, 1926 (Shelford) 1 ♂; Terrace, July, 1931 (Hippisley) 1 ♀; Quebec, Bagotville, July 26, 1934 (C. & Z.) 1 ♀. ALASKA: Pleasant Bay, Adm. I., May 14, 1932 (Hasselborg) 3 ♂. Admiralty Island, June 1933 (Sheppard) 1 ♂; Mole Harbor, Adm. I., June 3, 1932 (Hasselborg) 3 ♀.

This species is very closely related to *Lepthyphantes flavipes* (Blackwall) of Europe. The most striking differences are in the shape of the "lamella" which in *flavipes* makes a right angle turn near the tip and in the width of the lateral lobes of the epigynum which are wider in *flavipes* and closer to the scape.

The relationships of *Lepthyphantes zebra* Emerton and *Lepthyphantes sabulosa* (Keyserling) have been discussed under *sabulosa*.

Lepthyphantes sabulosa (Keyserling)

Pl. 5, Figs. 73-78

Linyphia sabulosa Keyserling, Spinnen Amerikas, Theridiidae, 2:70, pl. 13, f. 170. 1886; Marx, Nat. Mus. Proc. 12:529. 1890; *Bathypantes sabulosus* Petrunkevitch, Catalogue, p. 219. 1911; Worley and Pickwell, Univ. Neb. Stud. 27:34. 1931.

Male.—Length, 2.2-5 mm. Carapace yellowish orange suffused with dusky; darker at the margins and with a median longitudinal grey stripe, the eyes on black patches; viewed from above broad, evenly rounded on the sides to the cervical groove, convergent toward the front; the anterior eyes in profile; viewed from the side, gently arched over the back to the cervical groove where there is a slight depression and then gently arched over the head to the eyes. Clypeus straight, slightly protruding. Sternum and labium dark, near-

ly black over a yellow ground color. Endites yellow, suffused with dusky. Legs yellow, slightly darker distally in some. Ratio of length of tibia to that of metatarsus as 44 to 40. Tibiae and metatarsi spined above. Abdomen with ground color dirty white marked with scattered silvery spots and with four or five narrow transverse dark bands on the posterior half; basal half with a pair of large dark spots connected by a narrow dark cross bar; tip dark; the sides with a dark and a light stripe. Venter dark grey.

Posterior eyes in a slightly recurved line, the median very slightly larger than the lateral and separated by a little less than the diameter. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by the radius and from the lateral by the diameter.

Femur of palpus a little thicker distally, curved inward and then a little outward. Patella strongly convex above, very short below, armed dorsally with one large black spine. Tibia short, only a little longer than the patella, armed dorsally with a long black spine; viewed from above constricted at base, then widened, both sides convex, distal margin gently concave on the mesal half, the lateral angle slightly produced, broadly rounded. Cymbium rounded over the back, armed dorsally at base on the lateral side with a low protuberance, right angled behind, and on the mesal side with a short horn-like process, curved backward toward the base of the segment; the mesal angle has the margin expanded into a thin plate. Paracymbium strongly bent forming a very deep notch which is somewhat curved due to the fact that the posterior margin is concave and the anterior margin convex toward the notch; the extreme base is armed with four or five small hairs and there is a group of seven or eight stiff hairs on the middle of the basal part; the part back of the notch is armed with a ridge which ends laterally in a small, sharp, black tooth; the tip is spatulate, bent down towards the bulb and separated from the rest of the paracymbium by a deep notch lying between two teeth, the basal one much larger than the other. The visible part of the median apophysis is a thin, straight, acute, spine-like process. Radix smooth, not constricted and obliquely rounded at the tip. The embolus is thin and flat at base, armed some distance from the base with a conspicuous cluster of short, stout spines, the upper margin of the basal part acuminate, the terminal part swollen, acuminate, minutely granulate and armed on the concave side with a broad, thin, flat, obliquely pointed tooth; the duct opens on a black tubercle between the tooth and the end of the embolus, tip acuminate, strongly incurved, the end with a small black tooth and a rounded lobe. The terminal apophysis consists of four visible elements; next to the embolus is a very long slender process extending over the end of the bulb to the median apophysis, armed on the inner face on the basal third with a scattered row of stiff straight spines and fringed along one edge on the distal half with smaller oblique spines; the next process is shorter but slender and acute; the third process appears as an oval plate in the angle between the second and fourth; the last or terminal process is also long and slender, armed on the mesal side with a small tooth.

Female.—Length, 2 mm. Similar to the male in form and color, but with the abdomen usually a little larger, generally lighter in color and with dark

spots smaller and arranged in two longitudinal rows. Venter uniform grey except the epigastric plate which is yellow suffused with dusky.

The epigynum is strongly protuberant, produced backward, incurved, the tip developed into two broadly rounded lobes. The scape is narrow at base, then widens into a broad lobe which is folded forward beneath the hind margin of the atrium, then constricted and gradually widened to the end which is broad. From the center of the broad terminal part there arises the long slender finger-like process the tip of which is visible in the untreated specimens.

Type locality: Salt Lake, Utah.

DISTRICT OF COLUMBIA: (Fox) 1 ♀; Feb. (Fox) 1 ♂ 2 ♀; Apr., 1888 (Fox) 5 ♀; (Fox) 1 ♀; Sept., Oct., Nov., (Fox) 3 ♂ 5 ♀. GEORGIA: Tallulah Falls, Oct. 18, 1926, 8 ♂ 12 ♀; top of Blue Ridge, Towns and Rabun County Line, Oct. 18, 1926, 2 ♂. KANSAS: Blue Mound, Douglas Co., 1924 (Beamer) 1 ♂. MARYLAND: Cabin John, Dec. 3, 1918, 1 ♂ 1 ♀. MISSOURI: California, Dec. 8, 1904 (Crosby) 1 ♂; Mansfield, Oct. 1906 (Crosby) 1 ♂ 1 ♀; Columbia, July (Crosby) 2 ♀; Nov., 2 ♂ 2 ♀.

NEW YORK: Lake Bluff, Sept. 19, 1920, 1 ♂; Silver Bay on Lake George, Sept. 15, 1925, 1 ♂; Barrington, Oct. 27, 1918, 1 ♂ 2 ♀; Watkins Glen, Oct. 1918, 1 ♂; Ithaca, Mar., 1 ♂; Nov., 5 ♀; Dec., 1 ♀; Apr., 1 ♀; Apr. 9, 1919 (Dietrich) 1 ♀; Mar., 2 ♀; (Harwood) 1 ♀; (Banks) 1 ♀; May 4, 1919, 1 ♀; Mar. 2, 1919, 1 ♀; Lake Keuka, Sept., 1903 (Crosby) 1 ♀; Barcelona, Sept. 19, 1925, 1 ♀; Nov. 19, 1925,

1 ♀; Olcott, Sept. 19, 1925, 1 ♀; Penn Yan, Sept. 24, 1921, 1 ♂; Nov. 10, 1928 (Crosby) 1 ♀; Clarkeburg, Sept. 18, 1925, 3 ♀; Sea Cliff, Sept. 6, 1925 (Wolf and Taub) 2 ♀; Bluff Point, Fall 1904 (Heck) 1 ♂; Montour Falls, Oct. 12, 1924, 1 ♂ 1 ♀.

NORTH CAROLINA: Oteen, Oct. 16, 1923, 1 ♀; Goldsboro, Oct. 24, 1926, 1 ♀; Raleigh, Oct. 26, 1923 (C. & B.) 6 ♂ 3 ♀; Ashboro, Apr. 3, 1929 (Crosby) 1 ♀; Junaluska Gap, Macon Co., Oct. 17, 1926, 1 ♂ 1 ♀; Blowing Rock, Oct. 10, 1923 (C. & B.) 1 ♂; Montreat, Oct. 16, 1923 (C. & B.) 1 ♂ 1 ♀; Conee, Swain Co., Oct. 15, 1926, 1 ♂ 2 ♀. PENNSYLVANIA: New Bloomfield, Oct. 31, 1924, 1 ♂ 6 ♀. TEXAS: Dallas (Jones) 1 ♀. VIRGINIA: Roanoke, Oct. 7, 1923, 1 ♂ 2 ♀; Covington, Sept. 1905, 1 ♂; Alberta, Oct. 27, 1923 (C. & B.) 1 ♂; Dolphin, Oct. 27, 1923, 1 ♀; Mt. Vernon, Deer Park fence, Oct. 28, 1926, 2 ♂.

This species is closely related to *Lepthyphantes zebra* Emerton. The main differences lie in the length of the terminal apophysis and subterminal apophysis which are long and sinuous in *sabulosa* and in the accessory sclerite which is much longer and has many more spines in *sabulosa*.

Lepthyphantes ziba sp. nov.

Pl. 6, Figs. 79-80

Male.—Length, 2.1 mm. Cephalothorax clear orange-yellow, viewed from above rather broad, widest at second coxae, narrowed rapidly forward without a constriction at the cervical groove; eyes close together and the anterior eyes in profile; viewed from the side steeply ascending behind and rounded over to the cervical groove where there is a slight depression, then arched over the head to the posterior eyes. Clypeus nearly straight, slanting forward. Sternum gray over yellow, darker towards the margin. Labium dark. Endites orange yellow, lightly suffused with gray. Chelicerae orange-yellow, rather long, constricted from the outer side towards the tip. Legs and palpi orange-yellow. Abdomen white above with a double row of widely separated dark spots and

followed by a series of three or four narrow dark transverse lines; there is a black lateral line, below which there is a curved white line and below this a black line bordering the pale venter which is sometimes grayish in front.

Posterior eyes in a slightly recurved line, the median separated by two-thirds the diameter and from the lateral by the radius. Anterior eyes in a straight line, the median smaller than the lateral, separated by the radius and from the lateral by the diameter.

Femur of patella moderately long, compressed at base and gradually widening distally. Patella short, armed dorsally with a fairly strong spine. Ratio of length of femur to that of patella as 35 to 11. Tibia short and broad, armed dorsolaterally with a spine a little longer than the one on the patella. Cymbium smoothly rounded over the back, a small protuberance at the base on the mesal side. Paracymbium of the *zebra* type; the basal part with nine or ten small stiff hairs; there is no tooth on the inner flange, the outer ridge lacking on the posterior margin and rather low on the outer arm. Median apophysis armed with a single, long, acute tooth. Radix constricted near the base, widened in the middle, the mesal edge broadly and evenly rounded, the distal end acute. Embolus very narrow at the base, then greatly widened and grooved, the lateral flange wide, aciculate, evenly rounded and minutely denticulate. The processes arising from the radix are as follows beginning with the one next to the embolus; a slender, straight process ending in two long black connate teeth lying close to the base of the embolus; a longer process, somewhat swollen at the base but distally more slender and curved along the edge of the embolus, the side next to the embolus armed with numerous erect, black, spike-like teeth; a broad leaf-like, hyaline process with scalloped edge, its mesal edge blackened; the terminal apophysis which has the basal part fairly slender and nearly straight, sharply bent towards the cymbium at the edge of the paracymbium where it throws off a long, cylindrical curved, black pointed branch; the terminal part is thin, widened, aciculate, the tip obliquely truncate with a frayed edge.

Holotype, male: Lake Sutherland, Washington, Aug. 11, 1927 (C. R. Crosby) and one male paratype.

***Lepthyphantes zelata* sp. nov.**

Pl. 6, Figs. 81-82

Male.—Length, 1.8-1.9 mm. Cephalothorax yellow, strongly suffused with dusky, the radiating lines and an angular area on the back of the head darker, the margin nearly black; viewed from above evenly and broadly rounded on the sides to the cervical groove where there is a slight constriction and bluntly rounded across the front; anterior eyes in profile; viewed from the side steeply ascending in nearly a straight line to the cervical groove where there is a slight depression, then nearly level to the posterior eyes. Clypeus nearly straight and slanting forward. Sternum and labium nearly black. Endites gray except for an orange-yellow area at the base. Chelicerae light brown. Legs light yellow. Abdomen white above a dark pattern consisting of a basal area followed by transverse bars; below the white on the side is a lenticular

PLATE 6



79



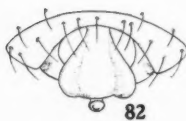
80



88



81



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86



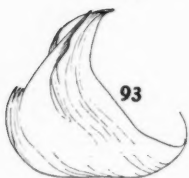
83



84



85



93



92



91

black band and below it another white band; venter dark gray, nearly black.

Posterior eyes in a slightly recurved line, the median separated by the radius and much nearer the lateral. Anterior eyes in a straight line, the median much smaller than the lateral, separated by the radius and from the lateral by a little less than the diameter.

Femur of palpus in side view nearly straight, not so much widened distally as in *zebra*. Spines on the back of the patella and tibia much smaller than in *zebra*. Tibia viewed from above relatively broader and shorter. Paracymbium nearly the same as in *zebra* but there is no tooth on the inner flange at the bottom of the notch. The other parts of the bulb are practically the same as in that species.

Female.—Length, 2 mm. Similar to the male. Epigynum is much like that of *zebra* but the visible part of the scape is relatively broader.

Holotype, male; allotype, female: Sol Duc Hot Springs, Washington. Aug. 12, 1927. Also 2 males and 10 females, paratypes, with the same data (C. R. Crosby).

This species is very closely related to *zebra* Emerton.

Lepthyphantes rainieri Emerton

Pl. 6, Figs. 83-87

Lepthyphantes rainieri Emerton, Can. Ent. 58:118, fig. 9. 1926.

Male.—Length, 2.7 mm. Cephalothorax chestnut brown, a little lighter on the head, a little darker at the margin and the surface finely reticulate; viewed from above broad, evenly rounded on the sides with scarcely any constriction at the cervical groove and converging anteriorly to the bluntly rounded front; anterior eyes in profile; viewed from the side evenly and broadly rounded over the back to the cervical groove where there is a broad shallow depression and then broadly rounded over the head to the eyes. Clypeus

PLATE 6

Lepthyphantes ziba

FIGURES

79. ♂, right palpus, ventrolateral view. 80. ♂, paracymbium.

Lepthyphantes zelata

81. ♂, paracymbium. 82. ♀, epigynum, ventral view.

Lepthyphantes rainieri

83. ♂, right palpus, lateral view. 86. ♂, paracymbium. (after Emerton)

84. ♂, right palpus, mesal view. 87. ♀, epigynum, ventral view.

85. ♂, right palpus, ventral view. (after Bryant)

Lepthyphantes furcillifer

88. ♂, right palpus, ventromesal view. 90. ♂, paracymbium, ventral view.

89. ♂, terminal apophysis.

Lepthyphantes pollicaris

91. ♂, cymbium, dorsal view.

93. ♂, terminal apophysis.

92. ♂, paracymbium.

nearly straight and slightly protruding. Sternum dark brown, nearly black, strongly convex and rugose, broad and broadly produced between the hind coxae which are separated by a little less than the diameter. Labium dark brown. Endites orange-yellow strongly suffused with dusky. Legs orange, the distal margin of the coxae beneath black. Abdomen with a grey ground color and scattered silvery spots, marked by a median basal black spot irregular in outline and followed by five or six transverse dark bars. The sides of abdomen are black with an interrupted light line. Venter black.

Posterior eyes in a slightly recurved line, median slightly larger than the lateral, separated by a little less than the diameter and from the lateral by a little less than the radius. Anterior eyes in a straight line, median smaller than the lateral, separated by half the radius and from the lateral by the diameter.

Femur of palpus moderately stout, slightly curved inward at base, not widened distally. Patella short, the sides slightly convex, moderately convex above and armed on the distal margin with a single large, straight, stiff, spine. Tibia swollen ventrolaterally, the dorsal margin broadly but somewhat irregularly rounded. Cymbium very obtusely angulate on the back, a small protuberance at base. The tooth of the median apophysis rather stout, strongly curved, black at tip, the distal margin smoothly and broadly concave, the opposite angle strongly chitinated, and right angled. The radix is rather long, moderately slender, gently curved, constricted near the base which appears rounded. Vesicle of the duct is semicircular. The embolus is slender, with a short, curved black tip. The terminal apophysis is broadly attached to the radix, then constricted and divided into two branches, the lateral one the more slender ending in two sharp points, one larger than the other, the mesal one broad at base and constricted, the tip widened and fluted ending in five or six small teeth. Near the embolus another process appears as a deeply concave plate, the edges of which are turned up and rounded, the tip is pointed. Paracymbium is broadly attached to the cymbium, the notch rather narrow and somewhat oblique with a row of long stiff hairs bordering the notch on the basal side and a few scattered hairs back of the bottom of the notch; paracymbium is greatly produced toward the base of the palpus, narrowed, upturned, and procurved, its tip bluntly rounded, the outer arm provided with a high ridge continuous with the lateral margin of the basal prolongation.

Female.—Length, 2.6 mm. Similar to male in color but the cephalothorax smaller and more pointed in front. The abdomen is larger than in the male.

Posterior eyes in a recurved line, median larger than the lateral, separated by one-third of the diameter and from the lateral by one-half the radius. Anterior eyes in a straight line, median smaller than the lateral separated by about the radius and from the lateral by two-thirds the diameter.

The epigynum is a transverse protuberant plate. The median lobe is strongly constricted anteriorly, broadly widened posteriorly with a rounded notch in the middle line behind at which point the tip of a finger-like process is exposed. The lateral lobes are concave toward the median line and separated from the middle lobe by a deep concavity.

Type locality: Paradise Park, Mt. Rainier, Washington.

COLORADO: Silverton, 9800 ft., Summer 1934 (Carpenter) 2♂ 2♀.

Lepthyphantes furcillifer Chamberlin and Ivie

Pl. 6, Figs. 88-90

Lepthyphantes furcillifer Chamberlin and Ivie, Bul. Univ. Utah **23**(4):32, pl. 10, f. 109-112. 1933.

Male.—Length, 2 mm. Cephalothorax dull grayish orange, the radiating lines and margin darker gray; two curved spines in a median line back of the eyes; viewed from above widest opposite the third pair of legs, the sides gently converging anteriorly without a constriction at the cervical groove; anterior eyes in profile; viewed from the side steeply ascending behind to the cervical groove where there is a slight depression, and then gently rounded over the head to the eyes. Sternum dark gray, much darker towards the margin. Labium dark. Endites pale yellowish. Chelicerae rather long and slender, divaricate at the tip, the sides coarsely striate. Legs and palpi dusky yellowish. Ratio of length of tibia to that of metatarsus as 1 to 1. Abdomen has a black margin and a dark pattern above on a gray background consisting of a basal median stripe followed by transverse black bars and surrounded by a row of pure white spots and a double row of white spots down the middle; a white sublateral line on each side; venter nearly black.

Posterior eyes in a very slightly recurved line, the median separated by a little more than the radius and a little farther from the lateral. Anterior eyes in a straight line, the median smaller than the lateral, separated by two-thirds the diameter and from the lateral by the diameter.

Femur of palpus a little thicker distally. Patella short, armed dorsally with a long spine. Ratio of length of femur to that of patella as 30 to 10. Tibia short, the dorsal distal margin smoothly rounded. Cymbium angulate at the base, and smoothly rounded over the back. Paracymbium very broad, obliquely concave, the basal part provided with a ridge armed with a row of stiff spines; four more spines are found in the concavity farther out; the outer margin is turned up in a thin ridge; the terminal part concave, the tip bluntly triangular. Median apophysis has the tooth short, black and very strongly curved; the radix is constricted near the base, mostly from the lateral side; the distal part smooth with nearly parallel sides; the end bluntly pointed; the embolus is small and delicate; the terminal apophysis rather broad at base, armed next to the paracymbium with a rather long, stout, black tooth, the terminal part narrower and curved mesally, armed on the mesal side with a slender tooth; the tip ends in two sharp points, the lateral one the longer.

Type locality: Clear Creek, South fork of Raft River, Utah.

UTAH: Red Banks, Sept. 3, 1933 (H. G. Richards) 1♂.

Lepthyphantes pollicaris sp. nov.

Pl. 6, Figs. 91-93

Male.—Length, 2.5 mm. Cephalothorax yellowish, lightly suffused with gray especially along the radiating lines and on the back of the head, the margin narrowly black; viewed from above broad, evenly rounded on the

sides, with no constriction at the cervical groove and bluntly rounded across the front; anterior eyes in profile; viewed from the side low, gently ascending behind to the cervical groove where there is a broad depression and then evenly and gently rounded over to the posterior eyes. Sternum dark brownish gray, black at the margin and behind. Labium dark. Endites pale yellowish. Chelicerae yellow suffused with gray except on an elongate area at the base, somewhat divaricate at the tip, the sides coarsely striate. Legs straw yellow with dark annulations at the base, middle and tip of femora, tibiae and metatarsi, lacking on middle of posterior metatarsi. Ratio of length of tibia to that of metatarsus as 1 to 1. Palpi straw-yellow. Abdomen light gray sprinkled with pure-white flecks above and provided with a dark pattern consisting of a basal median stripe, two pairs of spots followed by a series of chevrons and transverse bars; on the side an interrupted black stripe below which there is a middle sublateral stripe; venter black with a white transverse line in front of the spinnerets and a pair of oval white spots just back of the middle.

Posterior eyes in a slightly recurved line, the median a little larger than the lateral, separated by the radius and from the lateral by nearly the diameter. Anterior eyes in a nearly straight line, the median smaller than the lateral, separated by the diameter and a little farther from the lateral.

Femur of palpus a little thickened in the middle. Patella short and armed dorsally at the tip, with a long black spine. Ratio of length of femur to that of patella as 35 to 9. Tibia short, greatly swollen ventrolaterally. Cymbium armed at the base on the ventral side with an erect horn strongly curved laterally. Paracymbium of very complicated structure; the basal part thickly clothed with long stiff hairs; posteriorly from this area is a broad, smooth, concave area bounded by a distinct ridge in front; the outer side is folded back over the base of the paracymbium so as to leave only a narrow cavity between its inner surface and the smooth area just mentioned; the distal part is hyaline, strongly compressed and separated from the outer arm by a very deep rounded notch. Median apophysis armed with a short black curved tooth; the opposite angle produced and armed with a thin frayed crest. Radix strongly notched on the lateral side near the base, the distal part nearly straight, long and pointed. Embolus rather small, thin and dusky. Terminal apophysis a thin aciculate band, broad at the base, then narrower and again expanded, lying loose from the bulb, the distal part strongly curved mesally, armed on the lateral side at the broadest part with a blunt tooth and ending in two black points, the outer one, slender, acute, the inner one, broader and obliquely rounded at the tip.

Holotype, male: West Thumb, Yellowstone National Park, Aug. 28, 1927 (C. R. Crosby).

UTAH: Salt Lake City, Sept. 1930 (Gertsch) 1 ♂.

New Echinoderms from the Devonian Cedar Valley Formation of Iowa

Merrill A. Stainbrook

Since the publication of Thomas' paper¹ on the Devonian Echinoderms of Iowa, several additional forms have been collected. Their descriptions with the recent publication of Laudon² will bring the treatment of Cedar Valley Echinoderms up to date.

ECHINOIDEA

Devonocidaris thomasi sp. nov.

Plate 1, Figs. 5-7, 9

Description.—The materials collected consist of associated and separate plates and spines, interambulacral plates being most numerous and best preserved. Many of them are aggregated into areas which in one instance is 1.5 inches long and nearly as wide. They seem to approximate their original positions but probably are somewhat closer together than they were during life. Their cribriform structure is apparent under high magnification. Some plates are nearly circular, others are longer than wide, and some are rounded-pentagonal or rounded-oblong. They are approximately 0.5 mm. thick. Their upper surface is flattened, slightly elevated near the primary tubercle, depressed near the scrobicule and beveled toward the adoral margins. Three areas may be observed on complete, well-preserved plates: the intrascrobicular, the extrascrobicular and the marginal border. The intrascrobicular area is small, about one-fourth the transverse diameter of the plate, and separated from the remainder by a distinct, narrow, slightly elevated ridge forming a scrobicular circle. The primary tubercle generally is nearly central, but may be subcentral near the adoral margin. Scrobicule narrow and gently depressed. Basal terrace distinctly elevated above the scrobicule, sloping gently upward and merging with the boss. Mamelon low, smoothly rounded, broad, about one-third the width of the scrobicular area, perforate, the foramen being about one-third the diameter of the mamelon; neck short, separated from the boss by a slight indentation. Apparently only the large plates have primary tubercles, since the visible smaller plates show none. Extrascrobicular area large, depressed immediately beyond the scrobicular circle and gently convex beyond. Secondary tubercles small; apparently imperforate, although this condition may be due to wear; they are scrobiculate and generally 20-25 in number. The distinct scrobicular ring is composed of approximately 13 more or less

¹ Thomas, A. O., Iowa Geol. Surv. 29:385 ff., 1920.

² Laudon, L. R., Jour. Pal. 10:60 ff., 1936.

regularly disposed tubercles situated near the scrobicular circle; these average larger than the tubercles beyond the ring.

The exact number of rows of plates in an interambulacral area is uncertain; plates approximately in position suggest six rows. One of these is close to a row of ambulacral plates and may have been proximal to it. The sixth row beyond this is composed of smaller plates which overlap adapically and imbricate with the plates on either side; it may have been the middle row. The remaining plates imbricate adapically and radially with each other. A large, complete plate is 9.4 mm. long and a smaller one with no primary tubercle is 6.5 mm. long and 5.5 mm. wide. Another large plate is 8.2 mm. wide.

Except scattered pieces buried in matrix, most of the ambulacral plates are in a close series of 15. They form part of one side of an ambulacrum about 12 mm. long. Adjoining this series are a few plates from the other side of the ambulacrum. They are thin, transversely elongate, narrow and adorally imbricating. A typical plate is 5.3 mm. long and less than 0.5 mm. wide. Pore pairs are uniserial, transverse and central. The adradial pore is subcircular while the distal pore is elongate-oval and longer than its mate. Immediately exterior to the distal pore, the plate is slightly expanded, elevated and surmounted by a moderately large secondary tubercle; a smaller tubercle is adradial to the other pore. One plate shows two minute pits near the distal end on the adapical surface, which is generally covered by the plate next apicad in position. A thin, vertical brace projects inward on the underside of each plate, originates near the middle and increases in height toward the adradial suture.

Primary spines are stout, acicular, straight, and circular in cross section. In the type, they are broken and incomplete, the largest fragment being 10.6 mm. long and 1.4 mm. in diameter; judging from the taper, it may have been twice that length. The base of a typical spine is short and enlarges gradually to form an obscure annulus; beyond this the spine decreases slightly in diameter and then tapers gradually to a point: acetabulum circular and of moderate depth. Secondary spines are similar to the primaries in shape and may attain a length of 3 mm. All spines are marked by exceedingly fine, longitudinal striae which extend from the apex to the base.

Remarks.—Sea urchins are rare in the Iowa Devonian and only five species have been described, none from the Cedar Valley. Portions of a specimen said to resemble *Nortonechinus* were found in that formation north of Iowa City by C. H. Belanski several years ago, but are not available for study. In 1935 Dr. G. A. Cooper found a second example of the class which he gave to the writer; it forms the basis of this description.

The material does not permit determination of the size and shape of the complete test. No part of the lantern or of the apical system has been detected, but preserved characters place the specimen in the Lepidocentridae, whose genera have recently been discussed by Cooper.³ It resembles *Devon-*

3. Cooper, G.A., Jour. Pal. 5:141, 1931.

ocidaris Thomas in the form of the interambulacral plates, in the possession of small, transversely elongate, tuberculate ambulacral plates, and in the long, aciculiform, longitudinally striated spines.

Devonocidaris thomasi is distinguished from *Devonocidaris jacksoni*, the genotype, in having thicker, larger interambulacral plates, and a scrobicular ring on the interambulacra. The ambulacral plates are distinct in shape and have ovate, centrally situated pores. The plates also are strongly imbricate.

Occurrence.—Cedar Valley limestone in the independensis zone, on the left bank of Otter Creek by bridge on state road 11.

Holotype.—M.A.S. 1222. A portion also is in the possession of G. A. Cooper of the U.S. National Museum.

CYSTOIDEA

Agelacrinites fentonae sp. nov.

Plate I, Fig. 3

Agelacrinites sp. Thomas, Iowa Geol. Surv. 29, 421, pl. 44, fig. 6.

Description.—The material consists of two specimens, closely attached to a slab of limestone. The larger is partially decorticated, but preserves most of its structures remarkably well. The smaller is complete but less well preserved. The holotype was approximately 18.1 mm. in diameter; the paratype is 10.1 mm. in diameter.

Test circular, depressed, attached completely by the aboral surface; upper surface flattened, gently elevated centrally, depressed between the rays, and gently sloping near the periphery. Thecal plates imbricate, smooth and regularly polygonal, the larger ones nearly hexagonal. Peripheral wall composed of 5 rows of imbricating plates which are small along the outer border but are progressively larger in size adorally.

Rays are long and slender with slightly overlapping ends; two are contra-solar, the other solar. Their cover plates form two rows which meet in the middle in a zigzag imbricating line. Each row consists of elongate triangular plates, variable in length and width, generally large and small, alternating with those of the opposite row. The fifth ray more than half encircles the anal pyramid, which is subcentral between rays I and V and almost touches the end of V. Ten triangular plates, variable in size, compose the pyramid.

Remarks.—This species resembles *Agelacrinites hanoveri* Thomas from the Shellrock beds in shape and in the possession of two contra-solar rays, but differs in the position of the anal pyramid, in the fewer rows of plates comprising the peripheral wall and in not having the thecal plates curved adorally. It is named for Mrs. Mildred Adams Fenton who found the specimens and gave them to the writer.

Occurrence.—Waterlooensis zone of the Cedar Valley, one mile east of Brandon, Iowa.

Holotype.—M.A.S. no. 1219; Paratype M.A.S. 1220. Both are on the same slab of limestone.

CRINOIDEA

Stereocrinus harberti sp. nov.

Plate 1, Figs. 1-2, 8

Description.—The holotype is a somewhat crushed calyx from which a few of the plates are missing. The diameter is 32.5 mm., height 16.4 mm., and the diameter of the basal ring of plates is 8.3 mm.

The dorsal cup is basin-shaped with nearly vertical sides which are slightly concave immediately below the arm bases and expanded above; base flattened, gently depressed centrally and formed by the basals and radials only. Basal plates small, all equalling one radial; they extend but little beyond the column and have a slightly elevated outer rim. Radials large, wider than long, regularly hexagonal and slightly convex. First brachials slightly curved, larger than the radials and pentagonal in outline. First interbrachials are heptagonal, as large as the first brachials or larger and longer than wide. The plates above the first brachials and interbrachials are indistinct but seem to number 2, making a series of 5 plates from the column to the arm bases. The tegmen is too poorly preserved for study.

Plates of the cup are marked by low, rounded, narrow ridges, radiating from the center and making a pattern of triangles similar to those of *Stereocrinus triangularatus*. On each plate, a large ridge runs from the central point to the middle of each side where it meets a similar one from the center of the adjoining radial or brachial plate. Each radial has a double ridge extending from the center to the border of the adjacent basal. On each side of the central radiating ridge are 1 to 3 shorter ridges which also coincide with those on adjacent plates.

Remarks.—*Stereocrinus harberti* is considerably smaller than *Stereocrinus triangularatus*, is differently shaped, has radials only on the flattened basal portion of the cup and has more pronounced plate markings. It is smaller than *Stereocrinus bentonensis* with which it occurs, has a smaller basal area and its plate markings are more regular in appearance and not vermiform.

Dr. Edwin B. Kirk, who compared the type specimen with *Stereocrinus barrisi* of the Michigan Devonian, reports:

"In *S. barrisi* the ornamentation is more pronounced and of a different

PLATE 1

FIGURES

1-2, 8. *Stereocrinus harberti* n. sp.

1-2. Basal and lateral views of the holotype. x 1. (Harbert Coll.)

8. Radial plate. x 2. Part of the paratype (M.A.S. 1223).

4. *Stereocrinus bentonensis* n. sp.

Basal view of the holotype. x 1. (M.A.S. 1218).

3. *Agelacrinites fentonae* n. sp.

Oral view of the holotype x 3. (M.A.S. 1219)

5-7, 9. *Devonocidaritis thomasi* n. sp.

5. Basal portion of a spine x 3.

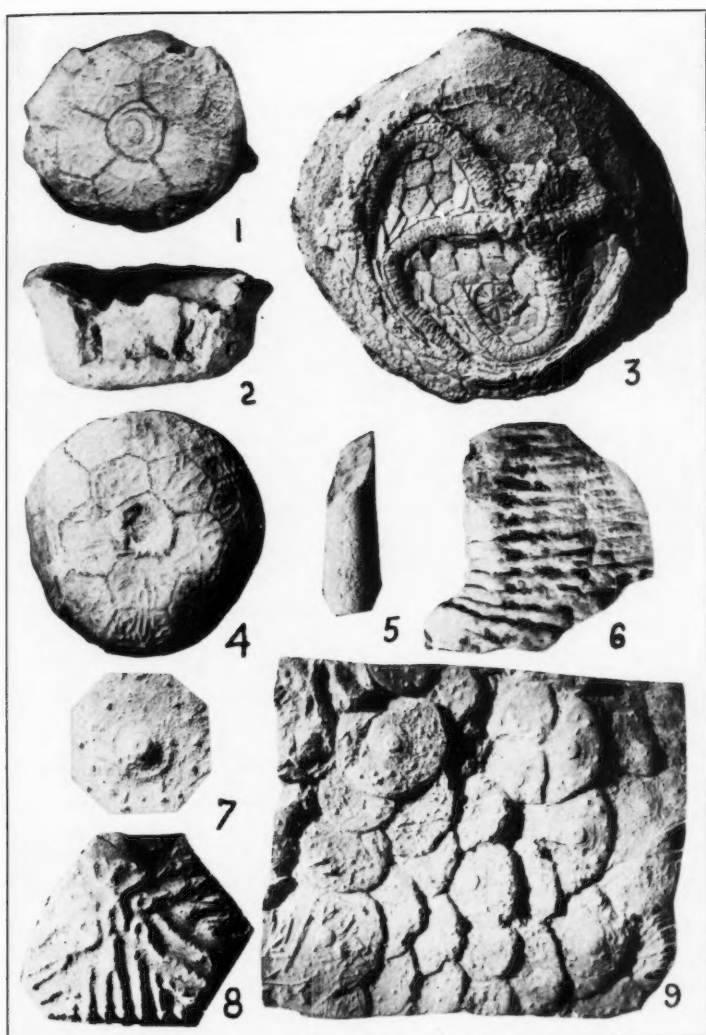
6. External view of a portion of an ambulacrum. x 3.

7. View of the scrobicular area of an interambulacral plate. x 3.

9. View of the exterior of a portion of an interambulacrum. x 3.

The row of plates on the left is probably the central one as it overlaps those on either side. All are portions of the holotype. M.A.S. 1222).

PLATE I



pattern. In *S. barrisi* as in *S. triangulatus*, the dorsal cup contracts at the arm bases. In the Cedar Valley species . . . the sides of the dorsal cup slope outward and if anything, have an outward flare at the arm bases. There are also differences in the relative shapes and proportion of the plates of the dorsal cup."

Occurrence.—The species is from the waterloensis zone of the Cedar Valley limestone 2 miles west of Palo, Iowa.

Holotype.—Collected by M. A. Harbert of Shellsburg, Iowa, who loaned it for study. It is now in his possession.

***Stereocrinus bentonensis* sp. nov.**

Plate 1, Fig. 4

Description.—The single specimen lacks the tegmen and part of the dorsal cup, but enough of the plates remains to give size, shape and other distinguishing features. Dimensions of the holotype: diameter 35.3 mm.; height of the dorsal cup to the arm bases 11.2 mm.; diameter of the basal ring of plates 10 mm.

The dorsal cup is broadly basin-shaped with low sides which are slightly depressed below the arm bases, straight for a short distance downward, and then abruptly curved inward at the upper borders of the first brachials; basal portion broad, depressed in the central part, gently curved outwardly and formed by the radials, first brachials and first interbrachials. The basal plates are small and the radials larger and hexagonal. The first brachials are pentagonal and as large as or larger than the radials. The first interbrachials are still larger and heptagonal. The plates above the first series of brachials are less well preserved and the sutures between them are obscure.

Ornamentation consists of narrow, irregularly vermiform ridges radiating from the centers of the plates, variably bifurcated and forming an obscure patterns of V's.

Remarks.—*Stereocrinus bentonensis* is larger than *Stereocrinus harberti*, has a distinctly vermiform ornamentation pattern, and has the first brachials and interbrachials partaking in the formation of the basal portion of the calyx. It is smaller than *Stereocrinus triangulatus* and has more irregular surface markings.

Occurrence.—Waterloensis zone of the Cedar Valley in association with *Stereocrinus harberti*, 2 miles west of Palo, Iowa.

Holotype.—M.A.S. 1218.

BLASTOIDEA

Nucleocrinus obovatus (Barris)

Nucleocrinus obovatus (Barris) Thomas, Iowa Geol. Surv. 29, p. 423 ff., pl. 36, figs. 1, 9, 16, 17, (not figs. 6-8), 1920.

Thomas illustrated one of the type specimens of Barris' *Nucleocrinus obovatus* and stated that its locality is uncertain. Examples recently collected at Partridge Point, near Alpena, Michigan, are apparently identical and there is little doubt that the species is a Michigan form. The specimen shown in Thomas' figs. 6-7, collected at Iowa City, Iowa, should receive separate specific designation.

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Description of a New Horse,

**Calippus regulus from the Clarendon Beds
of Donley County, Texas**

C. Stuart Johnston

INTRODUCTION

The material described in this paper is part of a collection obtained for the West Texas State College from a quarry in the Lower Pliocene beds of Donley County, Texas. This work was accomplished through the cooperation of the Works Progress Administration in 1936. The material presented is that of a small horse which was obtained from a quarry situated on the Grant property, two miles west of Goldston and was collected by a paleontological party under the supervision of Mrs. Margaret Johnston.

GEOLOGY OF THE BEDS

The sediments in this area consist of gray, somewhat calcareous clay. This clay is of such a character, and so interbedded in some instances with coarse sand as to indicate that it was deposited in an old river bed. Most of the Tertiary deposits of the High Plains region, as pointed out by Gidley (1903), are of this type. Many of the specimens collected are encased in hard calcitic concretions which render them difficult to prepare. Most of the material is fragmentary, and often shows evidence of having been water worn.

Calippus regulus sp. nov.

Fig. 1

Type: Mus. No. 878, right upper molar-premolar series (P^2-M^3) of an adult individual, all still in place in the maxillary.

Type locality: Grant Quarry two miles west of Goldston, Donley County, Texas.

Age: Lower Pliocene.

Diagnosis: This is the smallest of the family Equidae that has been discovered in the Clarendon Beds. Hesse (1936) figures an upper molar of this horse from the Beaver County Location in Oklahoma which he refers to the genus *Calippus*. He states that it is the smallest of the late Tertiary horses unless it is comparable with *Nannippus minor*. Molars and premolars alike are characterized by an extreme simplicity of the enamel pattern on the triturating surface. The posterior and anterior fosettes are relatively large

with no folding on their inner borders. The protocone is strongly connected to the protoselene. Parastyle and mesostyle are sharp and well developed. There is but little cement on the outside of the teeth.

Dental Measurements:

	P2	P3	P4	M1	M2	M3
Anteroposterior	15	13	13	11.5	11.5	12 mm.
Transverse	12	14	13	12	12.5	11.5 mm.

Total length of the above series 78 mm. Measurements were taken on the outer margins of the enamel. The transverse diameters were measured across the extremities of the mesostyle and protocone of each tooth. The teeth are moderately hypsodont and slightly curved transversally.

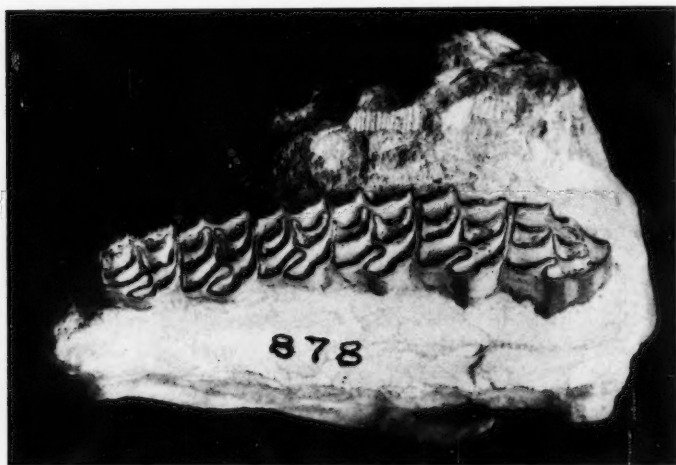


Fig. 1. *Calippus regulus* sp. nov., type, occlusal view, natural size, Lower Pliocene of Donley County, Texas.

RELATIONSHIPS

The genus *Calippus* was first proposed by Matthew and Stirton (1930) as a subgenus of *Protohippus* and *Protohippus placidus* Leidy was designated as the type. Later Stirton (1935) elevated *Calippus* to generic rank. Certain Pliocene species, formerly referred to *Protohippus* but not typical of that group, were tentatively placed in the genus. Stirton (oral communication), however, has recently concluded that *C. placidus* and the species described here represent a distinct genus. '*Calippus*' *martini* Hesse and '*Protohippus*' *ansae* Matthew and Stirton are probably referable to a subgenus of *Pliohippus* which is ancestral, at least, to certain species of *Equus*.

CONCLUSION

It is upon a basis of the characteristics and relationships above mentioned that it seems both necessary and important to establish the new species *Calippus regulus*. This small horse is not abundant, but is well represented in the Clarendon Beds. The most outstanding characteristics of species are, first, its very small size, and, second, the great simplicity of the enamel pattern.

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WEST TEXAS STATE COLLEGE,
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Book Reviews

ECOLOGICAL ANIMAL GEOGRAPHY. An authorized, rewritten edition based on Richard Hesse's *Tiergeographie auf oekologischer Grundlage*, Prepared by W. C. Allee and Karl P. Schmidt. New York: John Wiley & Sons, 1937. xiv + 597 pp., figs. 1-135. \$6.00.

The publication, in 1911, of Shelford's "Physiological Animal Geography," following closely after pioneer work by Adams and others firmly established the ecological approach to zoogeography. To Richard Hesse, however, must go the credit for the first compendium-like arrangement of the facts of animal geography in an ecological fashion. Due credit must now be accorded to Allee and Schmidt for translating Hesse's work into English, for deleting its Lamarckianism, and for adding much valuable material gleaned from their extensive field experiences. What impetus this volume will give to zoogeography no admiring contemporary can say, but few careful readers will deny that it towers above the plenitude of ordinary textbooks like an inselberg above a Saharan hamada.

Perhaps only those who are endeavoring to teach ecological animal geography will wear out copies of this book, but it will have wide use as a reference work for geographers and general biologists. It may be unseemly for one who has awaited this volume so eagerly to launch into a prompt analysis of its faults, but efficient use of it in teaching will be contingent upon an appreciation of the manner in which it must be supplemented in lectures. Its faults of omission are due largely to the unavoidable limitations of space. Since good books on oceanography and limnology are available, greater emphasis on terrestrial habitats at the expense of these topics would be preferable. Readers who do not have the German edition at hand will find it impossible to decide which sections are rewritten. A clear explanation of the viewpoint of ecology is unfortunately lacking. Technical terms are used or omitted in an inconsistent fashion. The various combinations of "steno" and "eury" are common, but many equally useful geographic or ecological terms do not appear.

The most serious criticism of the work is that it overlooks the recent revivification of geography by application of the ecological approach. Such basic concepts as the poverty of rain-forest soils, the influence of exotic rivers, the Föhn effect, and the physiological dryness of the tundra are either unmentioned or unemphasized, and the reader is not referred to source books such as James' "An Outline of Geography," Finch and Trewartha's "Elements of Geography," Peattie's "Mountain Geography," or Gautier's "Sahara: The Great Desert." Neither the Köppen nor Thornthwaite classifications of climates are treated. True rain-forest covers less of the globe than indicated and monsoon forest is of greater extension. "Steppe" is used as synonymous with "grassland" and not in the restricted sense preferred by many geographers and botanists. The climatic factors involved in the transition from rain-forest to desert are sadly slighted. The inclusion of a map of the major vegetation areas of the world, and a drawing of their arrangement on a theoretical, composite flat continent would be desirable. The final end papers of this, or any book, containing many metric system figures might conveniently display conversion tables.

The term "ecological valence" of Chapter II may be confused with "ecological equivalence" of other writers in the absence of any reference to the latter term. Also, Liebig's "Law of the Minimum" is actually a corollary of the "Law of Tolerance" and the latter should be discussed in a subsequent edition. I have found Stuart's "Principle of Forced Selection of Habitat"¹ useful, and other readers will think of additional ecological principles which should be included in this section.

¹ Occ. Papers Museum of Zool., No. 244: 31-32.

I have the temerity to disagree with the perennial notion, emphasized on page 30, that the tropics are rich in species but poor in number of individuals of component species of animals. If this is ever true it is a characteristic of the selva alone and not of the tropics as a whole. I am convinced that in each region of the world there are a few species with numerous individuals and many species with few individuals. In a collection of 1594 Pennsylvania frogs thirteen forms are represented, but two species comprise 42 per cent of the total; whereas in a collection of 420 frogs, of 21 species, made by the writer on Barro Colorado Island two species constitute 40 per cent of the total. My notebooks contain numerous supporting records, but it suffices to point out that failure to collect at night over long periods and the uncritical transference of a botanical truth to zoology have been principally responsible for the perpetuation of this idea.

Chapter VII would gain by more complete treatment of migration waves, as discussed by the junior editor in a publication² which is not everywhere available. Chapter IX stands in lonely isolation; most of its defined terms do not appear again.

Criticism of minor errors would unduly lengthen this review. No book of this magnitude can be perfected until a corps of specialists has read its pages critically. One is impressed by the highly successful manner in which the editors have corrected scientific names and avoided many mistakes. The minutiae listed here serve to indicate the types of errors which evaded their scrutiny. "Further" is invariably used in the sense of "farther"; "rainfall" frequently occurs when "precipitation" was intended; and both the spellings "Cameroon" and "Kamerun" are present. In the discussion of mangrove associations (p. 197) the important type, *Rhizophora* (Rhizophoraceae), of tropical America is omitted. Some of the illustrations are disappointing. Figures 123 and 124 should have been omitted entirely. The scarcity of typographical errors, the chapter bibliographies, and the complete index are noteworthy.—M. GRAHAM NETTING.

SNAKES ALIVE AND HOW THEY LIVE, by Clifford H. Pope. New York: Viking Press, 1937. xii + 238 pp., 65 photographs and 28 text figs. \$2.50.

When my friend Clifford Pope told me that he was writing a snake book I knew that we could expect a good book; when I saw some of the proof sheets I realized that the volume would exceed my expectations; and now that I have read the finished work I have no hesitation in acclaiming this as the best popular book on snakes which has appeared in recent years. Ditmars and others have published beautifully illustrated volumes which have nurtured interest in snakes, and which have facilitated identification of them. Pope, however, has given us a thoroughly readable book which answers all of the most common questions about snakes. Every busy herpetologist who has been haunted by queries concerning locomotion, longevity, and reproduction will keep this volume at hand where it can be thrust upon questioning visitors.

No other non-technical work on snakes indicates so clearly that science is accumulated knowledge or gives such deserved credit to other workers. The apt similes used by the author will be appreciated by all readers, but only herpetologists will realize the careful work that has been involved in the preparation of this volume. Pope's thorough knowledge of Asiatic snakes and his intimate acquaintance with Old World herpetological literature—shared by but few American herpetologists—would have enabled him to dash off a better than average book with little effort. It is apparent, however, that he chose the harder course and thoroughly surveyed and digested herpetological literature almost up to the minute of going to press. In consequence he has created an anomaly—a popular book in which each professional will find new facts and new references; a scholarly work couched in colloquial language.

The freshness of the illustrations will delight herpetologists, and their educational

² Schmidt, 1931, Lingnan Sci. Jour., 10:441-449.

value will set a new standard for similar works. The majority of the photographs illustrate behavior and principles as well as species and they are so integrated with the text that one feels certain that the author's forethought and Douglas Cullen's camera skill must have accompanied the genesis of the manuscript. From the standpoint of book-making a happy compromise has been effected between modernism and conservatism. The illustrations are effectively reproduced, sufficiently indented so that they will not be marred by careful trimming when rebinding becomes necessary, an eventuality which frequent use will hasten.

Although my own preference is for a numbered, rather than a lettered, key I must acknowledge the usefulness of the appendix "How to Identify the Snakes of the United States." Doris M. Cochran's accurate line drawings show facial expression in addition to scalation. The ranges given incorporate the latest knowledge, although regional experts may note minor errors. For example, there is no indication that *Lampropeltis getulus getulus* has been recorded from eastern West Virginia whereas *Pituophis melanoleucus*, of expected but not proved occurrence in West Virginia, is said to exist there. The separation of statements of range from the corresponding species in the key may be confusing to some readers, and in my opinion juxtaposition would be preferable. The index is gratifyingly complete.

Since every review must temper praise with criticism I fought down my enthusiasm long enough to search for errors. Few were found, but some statements will occasion heated discussion among herpetologists. The author gives some support to the proponents of poisonous snake eradication campaigns in the United States, although systematic slaughter except in populous areas is scarcely justifiable. Bubonic plague is endemic in some places in our West and tularemia is not unknown in the East. Either of these diseases is potentially far more dangerous than the pit-vipers which prey on rodent carriers. I question whether 160 persons die annually in the United States from snake poisoning. Even if the figure is correct it can be shown that a greater number of persons have fatal accidents in their bathtubs, against which there is no campaign. Certain vernacular names, always a source of argument, may occasion criticism. The author ably refutes the snake-milking-cow tale, but perpetuates it in the use of the common name "milk snake" instead of "house snake." For hatching snake eggs sand is recommended although in my experience clean sawdust is more mold-free. Snake eggs are more resistant to handling—even to numbering with ink—than the author indicates. The indigo snake, greatest of our snake-eating species, is slighted each time feeding habits are discussed. The chapter on popular beliefs should be lengthened, and a brief discussion of the diseases of captive specimens would be desirable in a second edition. These are but trivialities. I should be proud if I were capable of writing such a book as "Snakes Alive."—M. GRAHAM NETTING.

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